THE BOTANY

OF

THREE HISTORICAL RECORDS

Printed by R. & R. Clark

FOR

DAVID DOUGLAS, EDINBURGH.

LONDON . . . HAMILTON, ADAMS, AND CO.
CAMBRIDGE . . MACMILLAN AND CO.
GLASGOW . . . JAMES MACLEHOSE.

Seven ears of corn came up upon one stem rank and good; and seven thin ears and blasted with the east wind sprung up after them

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THREE HISTORICAL RECORDS

Pharaoh's Dream, The Sower, and The King's Measure

By A. STEPHEN WILSON

WITH ILLUSTRATIONS

EDINBURGH: DAVID DOUGLAS

MDCCCLXXVIII

PREFATORY NOTE.

The only bond of connection between one and another of the three following papers, is a common basis in the botany of the cereal grasses. These grasses have been the chief alimentary friends of man from early times. They have stood upon his oxgangs, and around the doors of his cottages and the tofts in which his cattle were sheltered, and have stored up for his winter days the sunshine of summer and harvest. Every point in their history throws a light on the history of man. If they were blasted by frost, or heat, or mildew, want and famine gave a new direction to society. If we can find out the character of the corn which Pharaoh's Dream regarded as symbolical of plenty, some comparison may be made

between ancient and modern views of the best forms of the cereals. If we can find out what was implied in the botanical illustrations of the Parable of the Sower, the progress of Eastern cultivation two thousand years ago will become historically more vivid. If we can find out what was regarded as the weight of a corn of wheat about the thirteenth century, we may be the better able to penetrate to the meaning of forces which sought to mould the commercial history of Britain.

North Kinmundy,
Aberdeen, *May* 1878.

ILLUSTRATIONS.

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I.

The Botany of Pharaoh's Dream.

The writer of the following papers has collected from many sources a large portion of the historical references, between remote times and the present day, to the European cereals, Wheat, Rye, Barley, and Oats. The purpose for which these references were collected was to form a proper historical basis for the intelligent cultivation of these cereals. If we do not know something of the character of the corn plants as cultivated in former times, and the returns of the crops which have been produced, we are apt to entertain erroneous views or exaggerated expectations of modern agriculture. The publication of such a historical review awaits the working out of several departments of research thus opened up.

When we examine the corn plants, many questions suggest themselves. Do these plants stand in the same alimentary relation-

ship to mankind as they did when Joseph laid up the surplus of the plenteous years in the granaries of Egypt? Are the physiological potentialities in an embryo of wheat as great to-day as when the Procurator of Augustus sent from Byzacium a stool, from a single grain, of nearly four hundred stalks? If the wheats of the ancient husbandry weighed fifteen or sixteen pounds, the *modius* —equal to sixty or sixty-four pounds the bushel—has our selection of the "best" forms resulted in any improvement? But what is an improvement? Have any new forms of corn arisen during the historical period? Have we lost any variety which was cultivated by the ancients? What means did nature employ to perpetuate the corn grasses before handing them over to Ceres? Has the annual sowing of many centuries tended to deprive the cereals of an originally greater amount of perenniality than they still retain?

It is beside the purpose of this inquiry to discuss all the forms of the cereals mentioned by the old rustic writers. While there can be no doubt that the ancient frumentum or triticum, hordeum, and avena, stood for our general

names, oats, barley, and wheat, there is less certainty when we attempt to identify the variety of wheat which the Romans called "siligo," or the variety of barley which they called galatic (Columella, *De Re Rustica*, lib. ii. cap. ix.) There is also little doubt that the zea of the Greeks, and far of the Romans, were some of the modern spelts; but whether the old names given to bearded and unbearded varieties can now be properly assigned, or whether indeed all the old varieties are now extant, may be doubted.

From the Bible we can gather something regarding the corn plants known to the Jews, or cultivated by them; while the frequent famines from which they suffered, imply that they had become to a large extent an agricultural people.

The name which in two places (Exod. ix. 32, and Isa. xxviii. 25) has been translated "rie," refers, it is believed, to one or other of the spelts. The other cereals mentioned in the Bible are wheats and barleys.

When the plague of hail devasted the valley of Egypt, the barley was in the ear, and was smitten; but the wheat and rie—

probably spelt (Triticum zea), which were sown at a later period of the season, were not smitten, the young leaves being close to the ground.

While Isaac sojourned with the Philistines in Gerar (Gen. xxvi.), his corn-land gave a return of an hundredfold. It is implied in the text that the crop was large; but no definite fact in the natural history of the plant, or in the method of cultivation, can be laid hold of. It needs nothing more than imperfect tillage and thin sowing, to secure several hundredfold, with either wheat or barley.

In the yearly contribution of twenty thousand measures of wheat which Solomon gave to the King of Tyre (1 Kings v.), it can hardly be doubted that there were the grains of a great many varieties of wheat. The ancient modes of threshing and storing were hostile to any permanent separation of varieties which would grow under the same conditions. Probably the number of such varieties has not been increased during the historical period. It is frequently affirmed that varying soils and modes of culture will divest an awny wheat of its beard, or change

the tint of one of the coats of the kernel. There is no better proof of these contentions than of the old belief—representative of some others—that "triticum," after the third sowing in wet land, was converted into "siligo" (Col. lib. ii. cap. 9). The bearded wheats of Columella and Pliny are probably the bearded wheats of to-day. No treatment has ever been supposed capable of stripping a barley of its awn, simply because all the barleys are awned. Certain forms of the oat have been called "wild," because they have refused to contribute much to man's maintenance, and ineffectual efforts have been made to reclaim them. Agriculturally they are not wilder than other forms of the oat. The *fatua* has been cultivated as long as the *sativa;* but no cultural influence seems as yet to have obliterated that peculiar spatular attachment of the locusta, hitherto little observed, which more than any other characteristic, differentiates the wild oat. The bearded wheats on Greek and Roman medals and coins, and Egyptian monuments, have not more persistently retained their awns, than their living descendants scattered to all parts of the world.

The wheats of "Minnith," in the Belka (Ezek. xxvii.) grown by the farmers of Judah and Israel, seem to have been in demand in the corn-market of Tyre. Probably Minnith was a remarkably good locality for wheat, so that when the husbandmen in other districts got seed from this place, they called it Minnith wheat.

Tristram, finding that composite wheat is at present grown at a place supposed to be Minnith infers that Minnith wheat was Triticum compositum. But this is very unsafe ground to go upon; there is no probability that these ancient wheats were unmixed varieties. We are somewhat in the dark as to what qualities were approved under the old modes of grinding: a woman who has to grind with the quern will give the praise to a soft wheat, while the modern miller, who wants as much fine flour as possible, prefers a harder wheat.

It was a law of the Jewish people, probably not well observed, that their fields should not be sown with mingled seed (Lev. xix.), or that their vineyards should not be sown with divers seeds (Deut. xxii.); the

implication being that mixed crops of wheat and barley, wheat and pulse, or other seeds, were usual in the ancient husbandry. Such crops have been in use in many countries down to recent times, and were a means of conveying from one land to another, in exported seed, forms of the cereals which by themselves might not have been deemed worthy of extended cultivation, or which in fact might have totally disappeared.

The "finest of the wheat" referred to in the Psalms, probably points directly or indirectly to the cultivation of different varieties, or to the practice of separating the larger seeds from the smaller and the seeds of grasses and other weeds. Whether the "principal wheat" of Isaiah (chap. xxviii.) refers to some approved variety, or implies that wheat was the chief crop, may be a question. But where the prophet at the same place tells us that "bread corn is bruised" because the husbandman cannot be threshing it for ever, there seems no doubt that he refers to one of the spelts. This has been pointed out by Dickson (*Husb. of the Anc.* ii. ch. 11).

In the present age of security and good

barns for preserving grain, we have some difficulty in understanding the reasons for the extended cultivation of far, or zea, or spelt, in ancient times. The ordinary wheats are found to be so much more prolific, and so much more easily threshed and cleaned, that we cannot but wonder at the use of an intractable grain by the Romans, so persistent as to mould the forms of their language. But the grain of far has a much thinner bran than the grain of naked wheat, and is also softer and more easily reduced by the pestle or other mode of manual grinding, and as the grain of far, like the grain of oats, is not beaten out of the pales or husk by threshing, it probably conserved its vitality and its sweetness better in the damp stores, sometimes under ground, of the early eastern culture, than the naked wheats, and was less liable to the attacks of mould and mice, and birds and insects. It would thus come into use by a form of natural selection. The more vital seeds of the mixed crop would take the lead, and gradually outnumber the others, although these might be alimentarily preferable. Cultural causes may also have

favoured the extension of far, but these need not be here considered.

From this slight sketch it will be seen that no hint is anywhere given in the Scriptures by which we are able to identify any form of the cereals anciently in use, with any form in use at the present day. But is such a conclusion fully borne out? Are not the commentators agreed that the corn of Pharaoh's dream was the branch-eared wheat Triticum compositum?

Let us see what the dream says. In the forty-first chapter of Genesis we read that "Pharaoh dreamed: and, behold, he stood by the river. And, behold, there came up out of the river seven well favoured kine and fat-fleshed; and they fed in a meadow. And, behold, seven other kine came up after them out of the river, ill favoured and leanfleshed; and stood by the other kine upon the brink of the river. And the ill favoured and lean-fleshed kine did eat up the seven well favoured and fat kine. So Pharaoh awoke. And he slept and dreamed the second time: and, behold, seven ears of corn came up upon one stalk, rank and good. And, behold, seven

thin ears and blasted with the east wind sprung up after them. And the seven thin ears devoured the seven rank and full ears. And Pharaoh awoke, and, behold, it was a dream."

In telling his dream to Joseph, Pharaoh says: "And I saw in my dream, and, behold, seven ears came up in one stalk, full and good: and, behold, seven ears, withered, thin, and blasted with the east wind, sprung up after them: and the thin ears devoured the seven good ears."

Joseph in his explanation says: "The seven good kine are seven years; and the seven good ears are seven years: the dream is one. And the seven thin and ill favoured kine that came up after them are seven years; and the seven empty ears blasted with the east wind shall be seven years of famine. Behold, there come seven years of great plenty throughout all the land of Egypt: and there shall arise after them seven years of famine."

Accepting the translation of this narrative, there is no direct mention of which genus the corn belonged to. Thus far, it may have

Seven ears of corn came up upon one stem rank and good; and seven thin ears and blasted with the east wind sprung up after them.

been wheat, or zea, or barley, or rye. And since the generic term, translated corn, is used, it is open to question whether the historian did not intend to imply that any of the corns would subserve the meaning of the dream? We do not know that the crops grown in Egypt in the days of Joseph were the same as those grown at the time of the Exodus, which, as already stated, consisted of wheat, barley, probably zea, with, no doubt, several others, such as millet. Nor amid the perplexities of modern criticism, are we to expect that a writer penning the history of Joseph, perhaps after the time of Samuel, should be fully instructed as to the corn actually pictured upon the dreaming imagination of Pharaoh. All that we can hope for is to get at the actual meaning of the writer, whether the phenomena referred to were based on his own observations, or had come to him by way of inspiration.

When Herodotus was in Egypt, about four hundred and fifty years before Christ, he found that while other nations fed on wheat and barley, it was accounted a disgrace for an Egyptian to do so; the Egyptians made

bread from olyra, which some called zea, kneading the dough with their feet (ii. 36). But if wheat and barley were at that time unclean to an Egyptian, the fact seems to show that these cereals were within reach, grown possibly for exportation, or other purposes. In another place (ii. 77) Herodotus tells us that those who inhabited the corn-growing part of Egypt cultivated the memory of past events, and were the best informed with whom he had held intercourse. "They feed," says he, "on bread made into loaves of spelt, which they call cyllestis; and they use wine made of barley, for they have no vines in that country."—(*Cary.*)

Sir Gardner Wilkinson (*Egypt and Thebes*, p. 213, and *Manners and Customs of the Egyptians*, ii. pp. 397-8) demurs to some of the assertions of Herodotus, and states that in the houses of the rich, bread was made of wheat, the poorer classes being contented with barley and flour of the *sorghum*. He also doubts whether the olyra and zea of Herodotus was Triticum zea, which is not now grown in Egypt, or the doura (*Holcus sorghum*) of the present day.

But it is quite possible that there may be some truth in what Herodotus says. For a long period the old Romans used zea or far in preference to wheat, and it is not impossible that when Herodotus visited Egypt, some districts may have been under the fashion of preferring zea to wheat, as is presently the case in some parts of Germany. Barley is presently held "in abomination" for bread in England, yet it is extensively grown. But this side light need not be farther pursued.

We seem then to have before us in this question three forms of corn, wheat, spelt, and barley; or including spelt among the wheats, we have simply wheat and barley, unless rye was anciently grown in Egypt and the adjacent countries.

Is there, then, any variety of wheat, rye, or barley, of a character agreeable to the description in Pharaoh's dream?

Seven ears of corn came up upon one stalk, rank and good.

If the Hebrew word translated "stalk" means culm, then there is no form of wheat, spelt, rye, or barley, which can by any stretch

of language be said to carry seven ears on one stalk, except the branching wheat, Triticum compositum.

One or two isolated facts, if they are facts, have been adduced in favour of the assumption that Indian corn (Zea mays) was anciently cultivated in the old world. And the conjecture has been made that the corn of Pharaoh's dream was Indian corn, because in some extremely rare cases there are seven cobs on one stalk. A Chinese picture of this corn is said to have been found, and some grains at Athens, and some under a mummy's head. But these discoveries are subsequent to the introduction of maize from America about 1520, and would hardly be worth notice on this occasion, but for the fact that respectable books of reference have lent some countenance to the notion that Pharaoh's vision was a picture of a stalk of maize. That such a plant should have been in cultivation in Egypt or Palestine in the days of Solomon, and should have entirely disappeared before the time of the earliest natural historians, is utterly incredible. That a plant having the picturesque character of

maize should have been in cultivation in ancient Egypt, and should nowhere appear amongst the sculptures, is also incredible. No description in the Bible of the processes of sowing, reaping, and threshing, or winnowing, seems to have in view the peculiarities of maize. The descriptive details of the corn plants given by Theophrastus, Varro, Columella, Pliny, and others, clearly refer to the European cereals. The zea of the Greeks, the name of which has been given by modern botany to Indian corn, was in all probability the unthreshable "bread corn" of Isaiah, now called Triticum spelta, or zea. That the historian of the Jews understood the corn of Pharaoh's dream to have been a wheat will be shown below.

Compositum differs in various respects from the other wheats in general cultivation. Its straw, like that of some other turgid wheats, is hard and nearly solid; the cells which form the inner part of the tube in other straws, extending in this to the centre, and forming a stem something similar to that of the palms. These cells, which fill up the interior, are in length from ·003 to ·006 of an

inch, and half as much in diameter, and would be cylindrical but for the mutual pressure which makes the transverse section favose.

But the most conspicuous characteristic of this wheat is in the spike or ear. In all other wheats, with very exceptional slight deviations, and in many of the forage grasses, the spike is regularly two-sided, the spikelets or clusters of florets on one side alternating with those on the opposite side. Why this should be so, when it is obviously not biologically essential, is a puzzling question. These spikelets may consist of one, two, three, four, five, or even six fertile florets, and one or more barren. Where there are from three to seven florets in a spikelet, they are placed alternately on opposite sides of an axis or branch coming out of the rachis, to a length of three or four tenths of an inch.

But in compositum, the spike or rachis is not in its lower portion two-sided, but many-sided, or rather without sides. There is always a main axis as in other wheats, which in good ears, exclusive of the awns, may be about four or five inches in length, the awns being about the same length. On the lower

part of the axis, when it is not branched and of good size, the spikelets are placed in any azimuth without regularity; two spikelets of four or five florets each, frequently originating almost at the same height, and perhaps ninety degrees apart. Towards the upper end from about half-way down, the rachis usually becomes two-sided, like ordinary wheats, the opposite spikelets alternating at their insertion. Many small ears have only one or two of their spikelets placed irregularly, the axis being two-sided from bottom to top. But in many good ears it is evident that the lines of cells which terminate in flowers and seeds have been crowded; and these, breaking out at the lower part of the spike, go on to form a branch or secondary spike, with alternating spikelets on two sides of it. The number of secondary spikes varies from one or two to six or eight.

The pales or flower-cups on these branchlets, are always smaller than on the principal axis; the kernels, consequently, are also smaller, while many of the florets are barren. Where the chief axis is four inches in length, the longer branches are about an inch and a quarter. But they are not merely longer axes

of the same character as the axis of the spikelets in other wheats. In ordinary wheats, only single florets alternate along the axis of the spikelet; while in composite wheat, spikelets of four or five florets alternate along the axis of a branch. And while the chief axis may carry twenty fertile spikelets, a branch has only about four. The kernels, also, are lighter in the branches than in the central axis. In the central axis they may average each three-quarters of a troy grain, or even a whole grain, and may number sixty or seventy; while in a branch the average weight will be less than half a grain, and the number from three to six. The drawings in various botanical works give an exaggerated character to the branches. Calmet's *Dictionary* (6th ed.), gives a plate which insinuates that the branches are sometimes as long as the main axis; misrepresenting nature to support a misconception. Ears of extreme excellence are stated to have had ten or twelve branches, and a hundred and fifty kernels. The above description applies to the plants which the writer has grown for the purpose of elucidating the present subject. Where an ear approaches to a hundred and

fifty grains, the main axis probably carries about eighty, and each of the branches from five to seven. But composite ears grown in France, received from Vilmorin of Paris, have scarcely any part of the main axis single or two-sided; the branches, or irregular spikelets, extending to within a little of the top, the ear appearing as one mass, not as many ears, and suggesting the description of a "fat" ear (Margin, Gen. xli. 5).

We have now to consider whether an ear of composite wheat will fit the conditions required by the dream.

Would any person naturally conceive of the little branchlets with a few kernels in them as distinct ears, or as good ears? They are only parts of one ear. To the eye, an ear of composite wheat seems as much one ear as the ear of a simple bearded wheat. The branches are crowded together and covered with long rough awns, presenting the appearance of a single mass matted together. The drawing alluded to (Calmet's *Dict.*, Eng. Trans., 6th ed.), with some of the branches lengthened out nearly to equal the main axis, in order to give it seven good ears, produces a

spike which has no warrant from observation.

The definition "seven rank and full ears" implies that each of the seven was rank and full, a definition which cannot be applied to the six branches of a compound ear. If the main axis standing on a culm of four feet in height, and carrying sixty or eighty kernels, may properly be described as rank, or fat and good, the small lateral branches cannot properly merit the same description. There were "seven" good ears, not one good ear, and six bad. Looked at by itself, a branch of a composite ear with half-a-dozen grains would be a miserable ear, scarcely deserving to be called an ear. The seven thin ears are not stated to have been on one stalk. They came up after the seven good ears. They were either "withered" or "small." But where ears of composite wheat are small, they have no branches, so that the seven small ears could not have been on one culm, and yet they are spoken of in a similar way to the good ears; ears being put as including the stalks they stood upon.

The seven good ears represented seven years of plenty; but a branch containing a few small seeds would be no proper symbol of a plenteous year. If the word "rank" properly renders the original meaning, then each ear, including its culm, was rank, for there were seven rank and full ears. And if the word "full," implied an ear which had a heavy load of fruit, then there were seven richly loaded ears in the foreground of the dream. But if the seven ears were all upon one rachis, there were not seven rank and full ears.

It may be objected that although the branches of a composite ear cannot be called good ears, or rank ears, or full ears, yet Pharaoh saw in his dream that these branches were good ears. But this is begging the question. It is because the commentators think they have found a wheat ear in its normal state, subserving the requirements of the dream, that they have accepted Triticum compositum. Pharaoh might have seen in a dream seven good ears of wheat or barley upon a stalk of papyrus. But it rather appears that he saw something in his dream

which he might have seen, and probably had occasionally seen in his waking observation. It is related by travellers that there may be seen at present in Egypt and Palestine ears of composite wheat, so that such ears probably appeared in the corn land of these countries in ancient times. Probably they did, as the crops everywhere, and in all countries, consisted, and still consist, of many varieties mixed up together; but the question is, Was any ear spoken of, or thought of, or dreamed of, as more than one ear? And as Pharaoh, or the Jewish prophet who relates Pharaoh's history, had never seen seven good ears on one stalk, while the record as it stands in English, distinctly says there were seven good ears on one stalk, we are next led to inquire, What is a "stalk?"

Any discussion of the original implications of the word translated "stalk" must be partly conjectural. There is no reason to suppose that the Jewish writers, any more than the writers of other nations, used their common words with philological accuracy or uniformity. Indeed, all common language is necessarily somewhat fluid. In fact the

shadings of objects of natural history into each other render any rigid use of terms difficult or impossible. The axis on which a flower or cluster of flowers stands has infinite varieties of length, extending upwards to a distinct stalk in the popular sense of the word, or leaving the flower so nearly sessile upon the root, as to be more properly called a stock or stem. Examples from the Bible might be given, in which one object, viewed in different aspects, receives two or more names. "There shall come forth a rod," says Isaiah (ch. xi.), "out of the stem of Jesse, and a branch shall grow out of his roots;" in which "rod" and "branch" imply the same thing, and "stem" and "roots" the same thing.

The question therefore presents itself, Did Pharaoh see seven good ears come up upon one stalk or upon one stem?

The dictionaries explain *stalk* to be a *stem*, and *stem* to be a *stock*. So that if what Pharaoh saw in his dream was seven ears upon one stem or stock, we have before us just an ordinary case of what is called tillering, that is, of a number of stalks or ears

being evolved from the embryotic cells enclosed in one ovary.

If a seed of wheat or barley is planted close to the surface, and with plenty of room, early in the season, it may produce from twenty to one hundred ears. The enormous number of nearly four hundred in one case, and three hundred and sixty in another, sent from Garada in Syria to two of the Roman Emperors, as mentioned by Varro and Pliny, is probably either exaggerated, or several seeds near each other may have contributed to the results, for Pliny thinks it worthy of notice that in some parts of Italy one plant has been seen to bear twenty-four stalks (*Hist. Nat.* xviii. 7). In ordinary modern sowing each seed has room to produce from two to five or six stalks. The old rustic writers were well acquainted with the principle of tillering, which indeed is nothing else than branching; Columella refers to the correction of thin sowing, from the shooting out of numerous stalks (*De Re Rust.* ii. 9).

By planting a seed deeply, the cells of the embryo are exhausted before the primary culm reaches the surface, and therefore little or no

branching takes place. By planting the same seed superficially, the potential culms in the embryo are at once enabled to go into buds.

Now Herodotus tells us that the Egyptians did not need to plough for corn. They sowed when the water subsided, and trampled in the seed by swine (*Cary*, ii. 14). Probably this was a local practice, or a practice more or less general at the time the historian visited Egypt; for the Egyptian sculptures give representations of the plough opening the ground before the sower, a roller following to cover or imbed the seed. Under such circumstances, common to many countries, shallow seeding must have rendered the phenomenon of tillering familiar.

But we are not left without more direct evidence that the dream of Pharaoh was a vision of fertile tillering. Josephus, in narrating the dream says:—"I saw seven ears of corn growing out of one root, having their heads borne down by the weight of the grain, and bending down with the fruit, which was now ripe and fit for reaping; and near these I saw seven other ears of corn, meagre and weak for want of rain, which fell to eating and con-

suming those that were fit for reaping, and put me into great astonishment" (*Antiq.* ii. 5., Whist). This is practically the same statement as if it had been said:—I saw seven ears growing out of one stem; because the secondary stalks do not in point of fact grow out of any of the roots, but out of the first or succeeding stalks, being organically branches.

In the dream, the word "ear" is used synecdochically for the whole culm. The seven good ears were seven rank stalks; the seven thin ears were seven short and blasted stalks. The same figure is used in other places. Ruth gleans ears of corn among the sheaves; the wicked are cut off as the tops of the ears of corn (Job xxiv.); the harvestman gathers the corn and reaps the ears with his arm, and gathers ears in the valley of Rephaim (Isa. xvii.)—in which cases more or less of the stalk was included in "ear," but on the ear attention was chiefly directed. The seven thin ears of the dream are not said to be on one stalk, and therefore it seems clear that "ears" are put for the whole culms or stalks, as well as for the ears, since the ears could not have come up alone. Seven ears

came up on one root, says Josephus, where the more fully expressed meaning of course is, that seven stalks bearing seven ears came up on one root. And therefore the seven rank or fat and good "ears" must also be held to be inclusive of the seven stalks on which they they stood. So that the "one stalk," was really the one stem or stock on which the seven "ears," implying and including seven culms or stalks, were sustained. The stem was common, and the seven good ears, and probably also the seven thin ears, each upon its own stalk, sprang up from the common stem.

In a certain sense, all the stalks or ears, from one seed of a cereal or other grass, even where there may be fifty or a hundred, come up "upon one stalk." The embryo is simply the most advanced of several stalks, taking the lead, and retarding the growth of others. Three stalks in initial stages may be seen in mono-multiple transverse sections of ungerminated barley embryos, prepared by the writer. When the primary stalk has advanced a certain length, a second plant or stalk, or bud or branch, appears at one of the lowest nodes. This new bud and stalk throws out roots to

feed itself. The primary stalk throws out another secondary at the next higher node. The first secondary throws out a tertiary, with roots at perhaps its lowest node. And this process of branching and rooting goes on till it may be seven stalks are evolved, or it may be seventy. But although each stalk throws out roots for itself, the whole cluster is organically connected. The stalks seem to consist of bundles or lines of root-cells, as well as stalk-cells. The stalks of a grass are capable of letting out roots; but the roots of a grass are absolute roots, apparently containing no lines of cells capable of throwing out stalks, and certainly never producing stalks. Organically, therefore, all the culms or ears are upon one stalk, or upon one stem, or upon one stock. All the tillers or stalks are branches arising from buds, and not arising from roots. In common language the primary stalk, which comes direct from the embryo, is called a stock or a stem until it ceases to throw out buds, and it is then called a stalk, upwards to the ear. (See Plate III.)

That the seven good ears of Pharaoh's dream were thus upon one primary culm, stem, or stock, but diverging or branching from each

Stem of seven thick and seven thin stalks.

other at the ground, and not at the rachis, is the most probable and natural interpretation. Seven good ears came up upon one stem rank and good.

There is perhaps nothing in the narrative implying that the seven thin ears came up upon the same stock as the seven good ears, but neither is there anything forbidding the assumption of this morphological unity. When tillering is not finished at an early part of the season, thin and small ears come up after the good ears at a later period, from some of the unexhausted nodes, and remain thin and small, either producing no fruit at all, or kernels, which shrivel up for want of sufficient nutriment and heat to elaborate them. A plant is thus produced with a certain number of rank stalks, carrying full and good ears, and a certain number of short stalks, carrying ears "thin and blasted."

In the illustrations here given for both views of the dream, I have supposed that the seven thin ears came up from the same stock as the seven good ears. The record does not say that the thin ears came up *beside* the good ears, but *after* them. Little can be

built upon this; but by assuming that the thin ears were upon the same stem as the rank and full ears, they are made to come after the full ears both in time and place; while the conception of the dream acquires an epic unity and force, not predicable of two separate plants. The thin ears are precisely in the position to seize and consume the full ears. In a physiological sense, probably not meant in the text, when the late tillers on a stock of wheat come into ear, they exhaust the plant; if they do not come into ear the plant will stand through the winter, and send up a second crop of stalks the following year.

Plate III. represents the manner in which a stock or stem of seven good ears and seven thin ears come up in organic connection.* The whole fourteen are in reality upon one stalk, stem, stock, stool, or stub. The lowermost node is in the embryo, from which node, and not from any imaginary quiescent radicle, the first set of roots take their rise. A nest of nodes exists in the embryo, and is carried up by growth. The inter-nodes are extensions of nodes. So long as an internode is able

* The leaves are removed to show the nodes.

rapidly to assimilate the pabulum absorbed by the young plant, the nest of nodes carried up by it remains nearly inactive. Whenever the internode begins to harden and slacken growth, the pressure of the new materials starts the next outermost node, which, stretching like a telescope into an internode, carries farther upward the central nest of nodes, with the ear standing in the axis. Only one bud is thrown out at a node, with an indefinite number of roots. From the first or second node of this new culm, another bud and roots may be thrown out; and so on till all the lower nodes, from which buds can issue, are exhausted. The lines of cells capable of forming buds are then carried up in culms, and frequently form abortive buds at higher nodes; the pressure of growth being no longer sufficient to carry them to complete culms. The process of tillering is thus not indefinite, because the direction of the whole process is upward from the surface, and roots which are thrown out in the air, especially if dry and unshaded, do not find their way to the earth. A hundred or a hundred and fifty culms are said to have been observed on one stem; I

have raised upwards of a hundred on a seed of barley, not all, however, coming to maturity; but the fact that tillering is limited by coming up into defective moisture, makes the ancient stories of three or four hundred culms doubtful.

The first Plate represents two ears of composite wheat, each having six branches, and the chief axis as a seventh. The second drawing (Plate II.) is from a rivet or turgid wheat. The dream does not say that the ears were of wheat but of corn, the generic term being employed, so that a barley or spelt plant of seven good and seven thin stalks might have been given with equal propriety. But as wheat was probably the chief corn of Egypt, a wheat plant has been preferred.

That a plant such as the second figure, in which seven full and seven thin ears come up on one stem, but diverging at the lower nodes, better represents the circumstances of the narrative, than a plant such as the first figure, with branchlets diverging from the rachis, becomes obvious on consideration.

The seven years preceding the famine were to be years of "great plenty." In the seven plenteous years the earth brought

forth "by handfuls." Now the composite ear in figure first contains 84 kernels, while the seven full ears in figure second, contain 550 kernels. No possible composite ear of seven branches could equal seven possible single ears. If one ordinarily good stalk with its spike of fruit was the usual return from a seed, and the normal supply for one year, seven stalks with their spikes full and good would be representative of such a super-abundant provision for seven years, as should leave a surplus for storing. It is, therefore, evident that seven ears upon one stem are a better symbol of plenty, than seven branches upon one rachis.

If it is contended that the symbol seen by Pharaoh may have been seven composite ears on one stock, this would imply a still greater abundance than seven simple ears; but it would be an abandonment of the proof for the cultivation of composite wheat in old Egypt furnished by the current view of the dream. If it is admitted that the seven good ears had seven rank stalks originating in one stem, stock, or stool, all clue to the variety of the wheat, or even to the species of corn,

instantly disappears. The seven ears of corn may have been of wheat, or spelt, or rye, or barley, or doura. There is probably no hint in any ancient writer, that composite wheat was peculiar to Egypt or to Palestine, or indeed that this variety was anywhere rigidly cultivated by itself, or regarded as a distinct variety, except by the curious. Theophrastus informs us that there were many kinds of wheat named from the countries in which they grew; such as the Libyan, the Pontic, the Thracian, the Assyrian, the Egyptian, the Sicilian; which differed among themselves in colour, size, and properties. Some of them again had their names from other sources, as *Canchrydias, Stlengis, Alexandrinus.* Some were spread amongst farmers at one time, and some at another, especially the sorts important as food. Some ripened early, others late; some grew to a large size and gave great returns, others were small and less prolific; some put forth large ears, others small; some remained long in the sheath, others were soon set free, as the Libyan; some had thin stalks, some thick, as *Libycum canchrydias;* some had few husks, others many, as the Thracian;

some had one stalk, on others many sprang up bigger and less (*De Historia Plantarum*, l. 8. c. 4, Gaza).

Wilkinson thinks the *olyra* which Herodotus found in Egypt, and from which bread was made, was Holcus sorghum, though the historian says some called it zea. Others have thought that *olyra* was the one-grained spelt (Engrain of the French). It is quite possible that although Herodotus says the Egyptian olyra was by some called zea, he did not intend to imply that it was the same plant as the Triticum zea of Greece. A traveller in Scotland might say the people there make their bread of oats, which some call Scots barley; or if in some parts of France, he might say the people make their bread of froment, which some call blé seigle, so that possibly a variety of doura may in Egypt have been locally distinguished by the name of zea. Dioscorides also says that olyra is of the same kind as zea, but less nutritious (*Med. Mat.* l. 2. c. 82). Even if olyra was H. sorghum, the calling of it zea implied the cultivation of Tr. spelta in Egypt.

The wheats of Egypt, says Pliny, held

the third place as to weight, yielding twenty-six pounds (12-oz. lbs.) of bread to the modius (peck). Adorea (the old name of far), zea or spelt, siligo and triticum, says Pliny, are common to many countries. Arinca was originally peculiar to Gaul, though now it is widely diffused over Italy. Egypt, Syria, Cilicia, Asia, and Greece, have their own peculiar kinds, known by the names of zea, olyra, and tiphe. The most prolific kinds of wheat, according to Pliny, were what he calls *ramose*, which some think may have been *compositum*. But as he speaks at the same place of a kind called *centigranium*, also thought to be *compositum*, it is probable that his ramose wheat was a sort notable for tillering; the ramoseness being in the stock of the plant, not in the rachis. It is also to be observed that the ear of various oats may be called *centigranium* if grown in favourable circumstances (*Hist. Nat.* xviii.)

Whether the composite spike of wheat is anywhere represented on ancient Egyptian sculptures, I shall not pretend to determine; I have never seen it on any coin or medal, but only simple bearded or unbearded spikes,

and copies from sculptures are to be accepted with caution. At the same time, there is probably no doubt that composite spikes were scattered over the wheat crops of ancient Egypt, Palestine, and all other wheat-growing countries.

Thus far, however, no evidence appears that composite wheat was ever peculiar to Egypt. The numerous allusions in the old writers on agriculture to the transmutation of one sort into another, is to be explained by the facts that many sorts were grown mixed up together; and that when any of the sorts found soil and treatment specially favourable, it supplanted the others. If a sample mostly of spring wheats and partly of autumn wheats, is sown for a few years, always in autumn, the spring wheat will be "transmuted" into autumn.

If the view of Pharaoh's dream taken in this paper is correct, it shows that the usual popular names of composite wheat, namely Egyptian and mummy, are based upon a misconception. On the same misconception have been originated the stories of this wheat having been restored to cultivation from the

hands of mummies, still retaining its vitality after the lapse of thousands of years. The person who made this restoration knew Calmet's view of Pharaoh's dream, and imagined that his contemporaries were not aware of the characteristics of the wheats growing about their fields. The commentator who first suggested that the corn of Pharaoh's dream was Triticum compositum, had himself seen ears of that wheat, so that this form could not have been restored to cultivation from any long preserved seeds. Indeed, Parkinson, who was his contemporary, speaks of this wheat under the name of "Triticum multiplici spica, double-eared wheat," and he observes: "Many of these sorts of corn have growne with us; but from whence some of them were brought we know not, saving the double wheate which groweth about Lyons."—(*Theatrum Botanicum. Cerealia.*) Gerarde also mentions a kind of wheat which has small ears coming out of a larger ear (*The Herball,* 1633). Triticum multiplici spica is also alluded to by Bauhine (*Enumeratio Plantarum,* 1589). This writer notices nearly twenty varieties of wheat.

Lobel and Tabernamontanus were also acquainted with composite wheat under the name of *multiplici spica;* so that it was universally known as double-eared wheat, long before it came to be associated with Pharaoh, or with mummies, or with Egypt. How long the French have called it blé miracle, I do not know, but in the interest of history it should be restored to its old popular name of double-eared, since it has only acquired the name of "Egyptian" and "mummy," from a mistaken view of Pharaoh's dream.

Thus the authorised reading that "seven ears of corn came up upon one stalk," may be wrong and probably is wrong; whereas the reading here proposed that seven ears of corn came up upon one stock, while probably expressing the full meaning, can only err by defect, and must necessarily be right, as embracing an essential morphological fact, common to all varieties of corn.

II.

The Botany of the Parable of the Sower.

In the Parable of the Sower there is an important statement based on the natural history of certain corn plants. To endeavour to find the meaning of that statement is the object here proposed. Doctrinal questions are not considered.

The Parable itself, as given by Matthew and Mark, stands thus :—

"Behold, there went out a sower to sow : And it came to pass, as he sowed, some fell by the way side, and the fowls of the air came and devoured it up. And some fell on stony ground, where it had not much earth ; and immediately it sprang up, because it had no depth of earth : But when the sun was up, it was scorched ; and because it had no root, it withered away. And some fell among thorns, and the thorns grew up, and choked it, and it yielded no fruit. And other fell on good ground, and did yield fruit that sprang

Parable of the Sower.

Some thirtyfold, some sixty, and some an hundred.

up and increased; and brought forth, some thirty, and some sixty, and some an hundred" (Mark iv.)

It is to the three returns mentioned in the conclusion that attention is directed. Matthew puts them in the reverse order: "But other fell into good ground, and brought forth fruit, some an hundred-fold, some sixty-fold, some thirty-fold (chap. xiii.) While Luke merely says, that the seed on the good ground "sprang up and bare fruit an hundred-fold" (chap. viii.); perhaps expressing a slightly different view from that of Matthew and Mark.

The narrative does not state the kind of seed which was sown. But if the meaning of the symbol, here adopted, be found tenable, the facts stated imply that the seed was neither zea nor barley, but wheat.

The view which has usually been taken by commentators, of the returns of thirty-fold, sixty-fold, and an hundred-fold is, that these are aggregate returns of different crops. And it has been sought to be shown that these returns indicate a fertility anciently in Eastern countries, of which modern tillage

affords no example. But such a course of reasoning proceeds on ignorance of the early agriculture; leaving out of account the radical distinction between what may be called the *ear-gift* and the *acre-gift*.

Let us notice a few correlative facts. According to the Septuagint, the seed from which Isaac received an hundred returns in the land of Gerar was barley (Gen. xxvi.) Herodotus observed that the corn in Assyria was matured under irrigation by hand and by engines from canals. "Of all lands," says he, "Assyria is the best for the growing of corn, being so fruitful as to yield continually two hundred-fold, and at its best three hundred-fold; the blades of wheat and barley growing to full four fingers in breadth"*

* Wilkinson says it has been conjectured that these broad leaves were leaves of the sorghum. The Greek finger or *daktulos* was about $\frac{3}{4}$ of an inch, making the leaves 3 inches broad. No such leaves are seen on any of the cereal grasses in this country; the broadest not exceeding $1\frac{1}{2}$ inch. Whether, therefore, the leaves grew broader in Assyria, or whether extinct varieties are referred to, or whether a plant neither wheat nor barley is described, or whether the historian exaggerated, is uncertain.

(i. 193 *Cary*). "The district of Cinyps, in Libya," says the same historian, "is equal to the best land in the production of corn, the proportion of the produce to the seed being three hundred to one, or as good as that of Babylon. The land also occupied by the Euesperides is good, and yields at its best a hundred-fold" (iv. 198). In speaking of the Crimea, Strabo says, that "certain plains are remarkably fertile in corn, yielding thirty-fold, with the most indifferent implements of husbandry" (7, 4, 6,). He also tells us that along the river Araxes, on the west coast of the Caspian, great crops grow without ploughing and without sowing; the ground which has been once sowed producing two or three crops, the first of which gives a return of fifty-fold, without a previous fallow; ploughed, not with an iron instrument, but with a plough made wholly of wood (11, 4, 3). "Susis in Persia," says the same writer, "is so fertile in grain that barley and wheat produce generally one hundred, and sometimes two hundred-fold. Hence," he adds, "the furrows are not ploughed close together, for the roots when crowded impede the

sprouting of the plant" (15, 3, 11). In some parts of Mauretania the straw is five cubits in height,* and of the thickness of the little finger; the produce is two hundred and fifty-fold. They do not sow in the spring, but bush-harrow the ground with bundles of the paliurus, and find the seed grain sufficient which falls from the sheaves to produce the summer crop" (17, 3, 11). Dickson (*Husb. of the Anc.*, chap. xxviii.) gives the following description from Pliny: "I have seen the fruitful field of Byzacium in Africa, that in corn produces 150 after one; which, when dry, the stoutest oxen cannot plough, after rain, opened up by a share drawn by a wretched ass on the one side, and an old woman on the other."—(*Natural History*, lib. xvii. cap. v.) Pliny also informs us that the plains of Leontium in Sicily, and other places in that island, as well as the whole of Boetica and Egypt more particularly, yield produce a hundred-fold (lib. xviii.) In contrast with all which take the following description from

* Probably about 7 feet 7 inches English. The writer has a plant of the wild oat (*Avena fatua*) brown-paled variety, 8 feet 9 inches in height.

Varro: "There are sown on a jugerum, 4 modii of beans, 5 of triticum, 6 of barley, and 10 of far; in some places a little more, in others a little less; so that you should observe what quantity is sown in the country, that you may sow what the climate and soil require, so as to reap ten after one, as in some places, or fifteen as in others; such as in Tuscany and some other parts of Italy."—(*De Re Rustica*, lib. i. c. 44, Dickson's trans.) In the same chapter Varro mentions the return of a hundred-fold at the places already named; so that such returns had been the wonder of those who practised agriculture under the Roman form, and were glad of returns of ten or fifteen.

But the question must be put, Was a *return* of one or two hundred a better *crop* than a return of fifteen?

The potential return wrapt up in a good seed of wheat, rye, barley, or oats, is from two thousand to six or eight thousand. A seed of some of the wheats, treated in the manner most favourable to tillering, may throw up eighty culms, averaging eighty grains each. A seed of two-rowed barley

may produce from fifty to seventy stalks, each carrying fully thirty grains.

But while these returns may at any time be reaped in the case of a few seeds, uncontrollable circumstances forbid that they should be reaped in ordinary culture. A good many seeds never germinate; a good many are eaten by birds, mice, and insects; a good many are starved for want of room and want of food; a few florets are left unfertilised; some grains are shaken out by the wind; some are eaten by birds; many are lost in harvesting; and many more in various ways before the remnant passes the meter. So that the return which reaches the sack of the husbandman is enormously reduced below the potential produce.

Now, in the old eastern husbandry, it is apparent that land was plentiful, and culture and seed deficient. Over the furrows, which were broken up at short distances apart, the seed was thinly scattered. If the soil was unexhausted, and the seeds deposited near the surface, with plenty of room, the circumstances were those which experiment finds favourable to tillering; so that although

many seeds may have fallen on the unbroken surface and have perished, those which fell on the partially open furrows were sufficient to return an ear-gift of one or two hundred to one, even after deducting incidental losses.

But the very conception of acre-gift did not enter into this mode of culture. The land was not closely cultivated, as it became in Italy, under the circumstances stated by Varro, or as it now is in Britain ; so that to speak of the return by the acre, or square unit, where only patches and furrows here and there carried a crop, would have been unintelligible. The returns were in respect of the seed, not in respect of the acreage. The returns were the ear-gift, not the acre-gift. To put the case at its extreme limit, a single seed might have been sown in an acre, and the return truly stated at five thousand to one.

Pliny tells us that in Syria the furrows were made extremely light, while in Italy they required the strength of eight oxen. And the furrows which he speaks of as carrying a hundred and fifty after one, ripped open by an ass and an old woman, indicate the character of the tillage. Josephus

(*Antiq.* 12, 4) tells us of one Joseph who sent his son Hyrcanus with three hundred yoke of oxen, two days' journey into the wilderness, to sow the land there. This implies precisely the sort of culture which gave large returns to the seed. The field was not restricted, and the seed was not hampered for want of room. The thick stalks mentioned by Strabo, carrying a return of two hundred and fifty, are just such as would grow in a virgin soil partially broken open, and with plenty of space for each individual plant. The enormous blades of wheat and barley mentioned by Herodotus as growing at Babylon (if he did not refer to some other plant), were not grown in closely-sown fields as in modern England, but in such rows and patches as could be gone round and round and carefully watered. The furrows, as Strabo says, were not ploughed closely together.

The servants of the householder, in the Parable of the Tares, could not have proposed to gather up the zizania (perhaps darnel, probably oats) from amongst the growing wheat if the crop had been a close crop, like

the crops of modern cultivation. The corn must have been in broken rows and patches susceptible of being walked through without being trodden down. And where the Deuteronomist says, "When thou comest unto the standing corn of thy neighbour, thou mayest pluck the ears with thine hand" (chap. xxiii.), it is perhaps indicated that the crop was thin upon the ground. Christ and his disciples walked through the corn-fields, plucking an ear here and there, rubbing out the kernels and eating them. And the crops in Palestine are still of the same character; they are "poor and light, and would disgust an English farmer. One may ride and walk through the standing corn without the slightest objection made or harm done. No wonder it is thin when white crops are raised from the same soil year after year, and no sort of manure put into the ground."—(*Tristram's Travels*, p. 591, quoted in *Fairbairn's Bibl. Dict.*)

The returns by the ear-gift and by the acre-gift can be compared only upon certain assumptions. A good crop now signifies a large acre-gift, a large produce on a small

surface; but it cannot be said whether an ear-gift of one hundred to one is a good crop or a bad crop—it is not a "crop" at all. It was not over a closely-tilled surface that Isaac scattered his ephahs of seed barley in Gerar; it was not over an acreage but rather over mileage; and as we do not know what breadth to assume for a furrow, we cannot compare a return by the acre's sowing with a return by the mile. But that any of the returns of one, two, or three hundred for one gave as much produce to the superficial unit occupied, as the fifteen returns of Varro, after a sowing of five modii of wheat to the jugerum, is not probable. Five modii to the jugerum are equal to two bushels to the acre, so that the returns of ten and fifteen on the corn lands of Italy were equal to twenty and thirty bushels upon the acre; indicating conditions of sowing and reaping not far different from those of to-day.

Only about a million of ears, says Captain Hallett (*Pedigree in Cereals*, p. 9, 1868), can grow upon an acre. A bushel of good-sized wheat grains numbers about half-a-million. Let us suppose that two bushels are sown

upon an acre, and that instead of many seeds perishing and many producing several culms, no seed dies, and no tillering takes place, and that so we have one ear for each seed sown.

Now if each ear carries thirty grains, there is growing in the field a return of thirty for one, making an acre-gift of sixty bushels, doubtless to be very much reduced in harvesting, threshing, and dressing. But as thirty grains are below the ordinary yield of an ear of wheat, it is clear that upon the Hetrurian fields, of which Varro speaks, as giving returns of ten or fifteen, the number of seed which perished must have been very great, while the number of ears upon an acre could not have much exceeded half-a-million. With a million of ears upon the acre, each ear containing thirty grains, each grain gives two bushels of produce.

But with a seeding of five modii (pecks) to the jugerum, or 2 bushels to the acre, there are about 23 seeds to the square foot; and it is the same to the proportional return, whether each seed throws one ear, or six or eight seeds throw up the 23 culms possible upon a square foot, equivalent to

a million upon the acre. To give a return of 100 for 1 on this seeding (which has been a customary seeding for wheat, on close tillage, along the course of history) each ear must carry 100 grains, making the gross produce 200 bushels. To give a return of 200 for 1, each ear must carry 200 grains, and the acre must produce 400 bushels. A return of 300 for 1, on the same conditions, requires an ear of 300 grains, and an acre-gift of 600 bushels or 75 quarters.

It is needless to add that under these conditions a return of 100 for 1 was never realised, much less a return of 200 or 300. An occasional ear of wheat may carry 100 grains or 150, but no ear of the varieties now in existence has ever carried 200. The average number varies with the variety, but in all varieties the average in a field is far below 100 grains.

We see, therefore, that to secure returns of 100, 200, or 300, or other larger numbers after 1, thinner seeding than 2 bushels or 1 bushel to the acre is an absolute essential. So that the conclusion presents itself that the ancient husbandmen who reaped returns of

100, 200, or 300 for 1, seeded at a rate below a bushel per acre, and reaped at a rate below 100 bushels;—probably far below, probably at the rates usual in the present day.

Captain Hallett recites an experiment in which, by planting one seed in each square foot, 1,001,880 ears were produced upon the acre, being at the rate of 23 ears for each seed. He does not give the gross produce, but let us assume that it was what he speaks of in other cases, 9 quarters per acre. To produce 9 quarters per acre each ear of a million must carry (setting losses aside) 36 grains; in which case the return is (23 × 36), 828 for 1.

In an experiment made by the writer to test the difference in productive power of whole seeds and half seeds of wheat, the whole seeds averaged $8\frac{1}{2}$ ears, and the half seeds $3\frac{1}{2}$. They certainly grew upon less space than a square foot, but say that each plant took that space. The wheat was a rivet or clog wheat (*Trit. turgid.*) and the ears averaged 73 grains, some carrying about 100.

In the case of the whole seeds, therefore,

there were ($43,560 \times 8\frac{1}{2}$) 370,260 ears upon the acre, and ($370,260 \times 73$) 27,028,980 grains, equal to 54 bushels, while the return per seed was ($8\frac{1}{2} \times 73$) 620. The ear-gift was 620 for 1; the acre-gift was 54 bushels; but there is no necessary proportion between the two.

The half seeds, producing $3\frac{1}{2}$ ears of 73 grains, give a return per seed of 256. And assuming as before that each plant occupied a square foot, the acre produced ($43,560 \times 3\frac{1}{2}$) 152,460 ears, and ($152,460 \times 73$) 11,129,580 grains, equal to 22 bushels.

In the light of these facts, consider the ancient returns of 300, 200, and 100 after 1, which have so much surprised the commentators on the Parable of the Sower, and on the Rustic writers:—A return of 300 after 1 on the modern system of tillage, and with the seeds planted a foot apart, would be a product of 300 kernels upon the square foot, which might be carried upon $4\frac{8}{7}\frac{8}{3}$ stalks of certain varieties of wheat, or upon 6 or 8 of other varieties. The produce upon the acre would be 26 bushels.

If 200 after 1 are carried upon the square foot, there may be from $2\frac{3}{4}$ stalks for each

plant up to about 5. The produce per acre will be $17\frac{1}{2}$ bushels.

On the same data 100 after 1 may stand on from $1\frac{3}{8}$ stalks to 3. The produce per acre will be about $8\frac{3}{4}$ bushels.

If a million ears upon an acre could each carry 100 grains, the crop would be 25 quarters. If each ear could carry 50 grains, the acre would yield $12\frac{1}{2}$ quarters. The ear-gift in the one case might be 2300 for 1, and in the other 1150 for 1. But the problem has strict biological and physical limits which cannot be transcended. A certain number of culms only can be grown upon an acre; and it is equally certain that the whole ear, which is formed at a very early stage of growth, cannot assimilate materials to produce more than a determinate number of florets.

There is no reason to believe that the ancient wheats carried a greater number of florets than the modern. Indeed the parable we are considering, according to the meaning here favoured, points out that the ears were similar to those now growing. Supposing, therefore, that the ancient return of 300 for 1 was grown upon the system of close culture,

23 stalks stood upon the square foot. We have seen that 23 stalks give a return of 9 quarters upon the acre. To make 9 quarters upon the acre 300 after 1, there must be sown on each square foot 2.76 seeds, while each seed must throw up $8\frac{1}{3}$ culms. If a certain number of the seeds perish, those which grow make up the difference by an increase of tillering. But if the best ancient culture produced only 300 after 1, it was very far beneath that which produces 828 or 620 after 1. And if an ear-gift of 828, along with an acre-gift of 9 quarters, is about the highest possible combination of both returns, we are certain that a return of 300 for 1 was a crop and also an ear-gift far below what may be attained in modern practice. That a return of 100 after 1 upon the old system of *extensive* tillage was regarded as marvellous, is an explanation of the perpetual recurrence of famine. It must always have been an easy matter upon the system of extensive cultivation to produce 100, 200, or 300 after 1, with seeds potentially able to return several thousands; but we may be certain that the actual returns, as estimated by the number of fertile

florets produced, was greatly in excess of 300 for 1, that excess being reduced from the inroads of wild animals, birds, and other causes.

The method of modern tillage seeks to combine the greatest ear-gift with the greatest acre-gift. What is formally required to effect this combination is the least number of seeds which will produce the number of culms of largest development for which an area has room. But the practical attainment of this combination can be desirable only when the seed saved is worth more than the labour of systematic planting. It is from overlooking this difference of method, where all land is appropriated, permanently occupied, and has to be made the most of, that the misdirected surprise has arisen, at returns of two or three hundred after one.

But that part of the parable with which these remarks deal is presented in two aspects. Matthew says (xiii. 23.), "He that received seed into the good ground is he that heareth the Word, and understandeth it; which also beareth fruit, and bringeth forth, some an hundredfold, some sixty, some thirty." Here it is the

"good ground" which seems to be personified, and which, in different cases of productiveness, brings forth the varying returns. The returns here seem to be aggregate returns from different fields. It is to this aspect of the parable that all the preceding discussion applies. This is the aspect in which the point is viewed by Archbishop Trench (*Notes on the Parables—"The Sower"*) and other commentators.

But there is another view which may be taken, sanctioned by the parable itself, both in Matthew and Mark, and by the explanation of the parable given by Mark.

The sower went out to sow. Some of his seeds fell by the wayside, some upon rocky places, some amongst thorns, and some fell upon good ground. But the seeds which fell upon good ground did not fall into different fields; they fell together upon the same patches. Mark accordingly says in his explanation of the parable (iv. 20), "These are they which are sown on good ground; such as hear the Word, and receive it, and bring forth fruit, some thirty-fold, some sixty, and some an hundred."

Here the seeds are what is personified, not the good ground. The meaning, therefore is, that in the common good ground, one seed gives a return of thirty, another a return of sixty, another a return of a hundred; all intermediate returns being likewise implied. Now this is precisely what happens. Apparently a short time before this parable was spoken, Christ and his disciples had been walking in the corn-fields, and plucking some of the ears. Perhaps their attention may have been directed to the varying numbers of kernels in the different ears. In consequence of a famine in Syria, twenty-three years before our era, Herod the Great imported from Egypt, and distributed in Judea, about a hundred and forty-two thousand quarters of corn (*Antiq. of the Jews*, xv. 9). So that undoubtedly the corn-fields about Genesareth presented a mixture of various forms of wheat; typical of men who in various degrees had multiplied their talents. Three bearded varieties of wheat are still common in Palestine.

In this view of the parable, the view which our illustration is intended to recommend, it is clear that tillering is not taken

into account. Indeed in many cases no tillering takes place; so that each single ear represents the return from each single seed. The kinds of wheat, says Theophrastus, called *sitanion* and *crithanian*, have no tillers (*De Hist. Plant.*, l. 8, c. 2). A certain trimestrian, or three-month wheat, is spoken of by Pliny, as being prolific and having a single stalk only. The same writer also mentions a kind called *centigranium*, hundred-grained, which must have been a kind carrying a hundred grains in one ear. If Pliny referred in this case to composite wheat, we might conclude that common ears of a hundred grains were unknown. At the present day in Britain, several varieties of wheat occasionally produce ears containing a hundred grains. But such ears are produced only where a good seed has plenty of food and room for full growth.

If we adopt the view that the returns on the good ground were not aggregate returns from whole fields, but that they were returns from individual seeds, the parable becomes striking and picturesque. On the common good ground, a stalk stands here bearing

thirty grains within its pales; another there, bearing sixty grains; while another bends its matured spike under a load of a hundred grains.

It was not "some" fields, nor "some" good grounds which returned thirty, sixty, and a hundred-fold; it was "some" of the seeds, all equally thrown into a common good ground, which gave these returns. Each seed was an individual personation; and according to its species, capacity of expansion, and other circumstances, it threw an ear of thirty grains, or any other number up to a hundred; the three numbers given being merely typical of good ears under the local conditions of husbandry to which the imagery of the parable appealed.

Different seeds of wheat contain different potential returns; a seed of half a grain weight has received from nature fewer talents than a seed of a whole grain. A seed of a troy grain weight has a large embryo, and a larger store of albuminous food for the young plant, than a seed weighing half a grain; and the writer's experiments show, that when a seed of wheat is deprived of part of its nourishment by the cut-

ting away of part of the kernel, the plant does not attain its natural size; so that under the same circumstances, in the same good ground, a larger seed sends up a thicker stalk and a larger ear than a smaller seed; and by having also longer and thicker roots, is able to appropriate more food and to produce a harvest of heavier grains than a smaller seed.

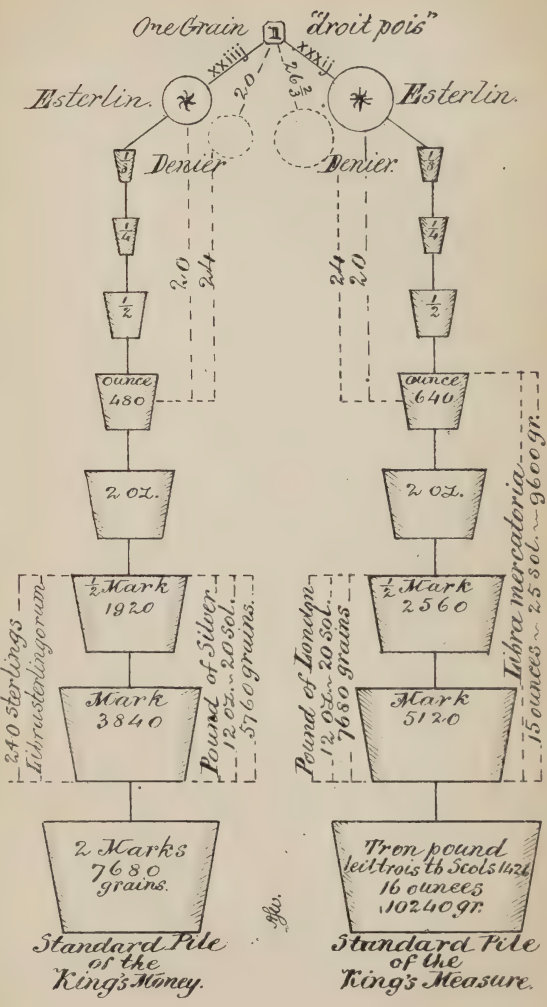
Thus viewed there is a mine of meaning in the parable, and a recognition implied of a multitude of natural facts; while a light is thrown on many passages referring to inherent differences of individual men, and the appropriateness of graded rewards.

Where stalks come up closely together, in patches, or in whole fields, it is popularly assumed, and is to a great extent true in fact, that each ear is the product of one seed. When, therefore, it was said that one seed had returned thirty, another sixty, another a hundred, the senses of the hearer were directly addressed. He could pluck an ear and verify the mechanism of the parable upon the spot. He had not to wait till various fields were harvested, threshed, and measured, in order to find out the returns meant by the

parable; in any patch of the good ground, he could find at once the plants which had heard the word of sun, and shower, and soil, and had ripened thirty, sixty, or a hundred kernels of golden grain; and which there waved before him in the harvest light, the fitting symbols of men who had received the Word of truth, and had brought it to all the perfection of which their various natural characters were capable. Each seed and stalk, with its bearded ear, represented a man. The thirty-grain stalks, lowest and feeblest on the field, had risen from the smaller seeds, or from larger seeds unfavourably placed; had found obstructions to their roots not easy to overcome, and stood there unabashed in the presence of greater stalks, having done their humbler assimilation well, and typifying the ranks of honest industry. The sixty-grain stalks had come from heavier seeds. They were stronger and taller upon the ground, but fewer in number. Their spikelets had been nursed in youth by far-reaching roots, and exulted in three and four fertile florets. They were the middle class of the cereal society. Here and there, almost in loneliness, the

centi-granians bent their heads with loaded spikelets, each bearing five or six round and shining grains. Their beards stood out like open fans. Their stalks were like young willows. Their leaves were two fingers and a half in breadth. And they carried bread-corn within their glumes to the weight of half a golden shekel. They were types of the kings of thought and forethought; of the men who have brought man and nature towards parallelism. And all grew harmoniously upon the good ground, pregnant with moral lessons for such as could read.

The Troy Weights.



III.

The Botany of the King's Measure.

The position is usually held that the weights and measures of England were initially derived from the weight of thirty-two grains of wheat. Whether that position is true or false is not a question of botany but of metrology, and as such will be treated in the author's proposed History of British weights and measures.

The present inquiry is chiefly concerned with the question, What is the weight of thirty-two grains of wheat? If this question can be answered within narrow limits, the historian of weights will then be able to say what was the proposed weight of the sterling penny, the ounce, and the pound, under the reign probably of Henry III. or Edward I., as defined in the *Assise of Weights and Measures.*

If the mere opinions of those who have referred to this point could be accepted, the

present inquiry would be needless. Stow tells us (*Survey*, p. 45, ed. 1598) that in the coinage of the 8th of Edward I. the penny-weight was 24 grains; "which 24 by weight then appointed were as much as the former 32 grains of wheat." There is nothing in the record to support this contention; and if the *Assise* of the 32 wheat corns belongs to the 31st of Edward I., the alleged substitution is anachronistic. In *The Annals of England*, under 1279, the same author tells us that the penny was "to wey 24 graines;" and also that, "at this time twentie pence wayed an ounce troy weight." Skene, writing in the sixteenth century, tells us (*De Verborum Significatione.* STERLINGUS) that the sterling "est genus ponderis, ane kinde of weicht conteining threttie twa cornes or graines of quheate;" and he adds, "the sterling pennie is swa called, because it weyis sa mony graines, as I have sindrie times proven by experience:" the author is evidently speaking both of a scale weight, and of a silver coin. Professor J. E. T. Rogers, writing in the light of experimental science, informs us (*A Hist. of Agr. and Prices in*

Eng., ch. x.) that "the weights and measures of the English standard from the Conquest to the close of the fifteenth century were founded on a rude natural system, the weight, namely, of 32 grains of average wheat taken from the middle of the ear." And "it has been found," he adds, "that 32 grains of such wheat weigh as a rule 22.5 troy grains." The valuable article on "*Weights and Measures*," in the *English Cyclopædia*, unhesitatingly assumes, "that the ear of barley and of wheat were actually used in determining the standards, seems to admit of no doubt," an assumption which could only have been made in forgetfulness of the units in Domesday Book and the older Saxon records.

Before quoting the records which contain our information respecting the 32 grains of wheat, it may be noticed that the statement of Stow, that 24 grains were equal to the former 32, is merely his own opinion. Right or wrong, Stow was also clearly of opinion that the weights in use at the Mint under Edward I. were the troy weights commonly used at the time he was writing.

Skene seems to imply that the sterling

was a scale weight; and that he had found by actual trials that it counterpoised 32 corns of wheat. But he affords no clue to the ponderal value of his wheat corns, nor to the relation which they bore to troy grains.

Rogers, writing under the assumption that Folkes had discovered the true theory of the Mint and of the Anglo-Saxon and Norman metrology, tells us, "it has been found" that 32 wheat grains weigh but $22\frac{1}{2}$ troy grains. He does not say that he found this result himself, nor does he say who did find it.

Now, do 32 wheat grains weigh either 24 troy grains or $22\frac{1}{2}$, or was it originally meant that they should? We thus come to the records.

In the first volume of *The Statutes of the Realm*, amongst documents of unascertained date, is given from the *Liber Horn*, fol. 123, the *Assisa de Ponderibus et Mensuris*, as follows:—

"Per ordinacionem Tocius Angl. regni, fuit mensura dni. Regis composita, videlicet, qd. denarius Anglicanus qui vocat sterlynges, rotundus & sine tonsura ponderabit xxxij grana frumenti in medio spice. Et uncia

debet ponderar. viginti denarios. Et duodecim uncie faciunt libr. London.

[Vidz. xx. solidos sterlingorum.]*

Et viii libre faciunt galonem vini. Et octo galones vini faciunt bussellu. London. Et octo busselli faciunt quartin. London. Et duodecim libre & di. faciunt petram London." etc. etc.

The various readings in this article, as it stands in the "Assisa Panis et Cervisie" (*Statutes of the Realm*, vol. i., p. 199), may be seen as under :—

"Par [discrecoem] tocius Regni Angl. fuit mensura Dni. Regis composita; videlt., qd. denar. Anglicanus qui dicit sterlingus, rotundus sit & sine tonsura & ponderabit triginta & duo gna. frumenti in medio spice; & viginti denar faciunt unciam; & duodecim uncie faciunt libram; & octo libre faciunt galonem vini & octo galones faciunt bussellum London. quot est octava ps. quartii."

The reading in the *Tractatus de Ponderibus et Mensuris*, 31 Edw. I., from the Cottonian MSS., quoted in Parliamentary Report of 1758, relating to weights and measures, page 414, is as under :—

* Interlined in the MS.

"Per ordinacionem tocius Regni Anglie fuit mensura Domini Regis composita, videlicet, quod denarius, qui vocatur sterlingus, rotundus, et sine tonsura ponderabit triginta duo grana frumenti in medio spice; et uncia ponderabit viginti denarios, et duodecim uncie faciunt libram *London*, et duodecim libre et dimid. faciunt petram London, et octo libre frumenti faciunt galonem, libra continet viginti solidos, et octo galones faciunt bussellum London," etc.

The 12th Henry VII., c. 5, enacts, "that the mesure of the bushell conteyn viij galons of whete, and that every galon conteyn viij li. of whete of troi weight, and every li. conteyn xij unces of troy, and every unce conteyn xx sterlinges, and every sterling be of the weight of xxxij cornes of whete that grewe in the myddes of the eare of the whete, according to the old lawes of this land."

The usual English version from the *Assise of Weights and Measures*, so far as it affects the point in hand, is given in *The Statutes of the Realm* as follows :—

"By consent of the whole Realm the King's measure was made, so that an Eng-

lish penny, which is called the sterling, round and without clipping, shall weigh thirty-two grains of wheat, dry in the midst of the ear; twenty pence make an ounce; and twelve ounces make a pound; and eight pounds make a gallon of wine; and eight gallons of wine make a bushel of London, which is the eighth part of a quarter."

Besides what thus assumes to have a statutory or quasi-statutory authority, we have a reference to the 32 wheat grains in the book called *Fleta*, supposed to have been written in the reign of Edward I. It is there said (lib. ii., c. 12), "Per discretionem discretiorum totius regni Angliae fuit mensura Domini regis composita, videlicet, per denar. Angliae qui sterling. appellatur, et fit rotundus, qui debet ponderare triginta duo grana frumenti mediocria, et unde viginti denarii fac. unciam, et duodecim unciae faciunt libram viginti solid. in pondere et numero; et pondus octo librarum frumenti fac. mensurum jalonis et octo jalonatae frumenti faciunt buss. de quibus octo consistit commune quarterium. Item denar. sterling. sicut dictum est, ponder triginti duo grana frumenti, et pondus

viginti denar. fac. unciam, et quindecim unciae faciunt libram mercatoriam," etc. (*Parliamentary Report*, 1758, p. 419).

If the Assise of David I. is a genuine record, or only partly corrupted, we have in that assise an earlier reference to the 32 wheat grains than any of the above. In this *Assise of Weights and Measures*, made at Newcastle-upon-Tyne, the sterling is said to be 32 grains of good and round wheat. And in the corresponding Assise of Robert III., it is said the sterling had, in the time of King David, 32 grains of good and round wheat (*Scots Acts*, vol. i.)

Amid many irreconcilable differences of essential importance, these English records seem to agree in one point; they relate to *measures* and not to *money;* by decree or consent of all the English kingdom was the *measure* of the Lord the King made. Perhaps the Article in question, or the substance of it, whether it had the value of a statute or not, is older than the reign of Henry III.; perhaps coeval with the introduction of the esterlin money penny in 1175. By some it is supposed to be of date the 31 of Edward I.;

in which case it would assume the character of a fragment of the Cottonian *Tractatus* of the same date, above referred to, abstracted and varied in facts and arrangement by different copyists. Or it may be that Fleta is really the original record; for if this treatise was written, as Lord Campbell says, after, and not much after, the 13th of Edward I., the "statute" of the 32 wheat grains cannot belong to the 31st of that king.

It has not been determined which reading, if any, is statutory; nor which chain, if any, from 32 wheat grains up to a quarter, is organic; eight pounds weight making a gallon of wine in one reading, and eight pounds bulk of wheat making a gallon in another reading. That part of the Scots assises which refers to the relationship between the 32 wheat grains and the sterling has clearly in view the money sterling, or silver coin, and is, therefore, probably a late interpolation, based on a misconception of the English records. But the full consideration of this and other points is reserved for a more extended review. Meantime attention will be directed to some of those experiments which

the writer has made with a view to determine the statical value of the assigned basis of 32 corns of wheat. They exhibit in proper relation to each other upon the ear the weight of each separate corn on various ears of many common varieties of wheat grown in England, Scotland, and France, with samples from these and other countries. The top of the scheme represents the top of the ear, each horizontal line showing in hundredth parts of a troy grain the weight of each corn in the descending spikelets.

No. 1. A white-chaffed red wheat, unbearded, close rachis. Ear 4 inches long. Grains very dry.

Side *a*.	Side *b*.
46*	63
62 60	88 63 —
75 55 75	83 67 83
81 68 82	89 — 61 87
85 77 57 87	93 70 80 93
83 86 67 91	— 73 86 95
90 71 86 93	91 81 52 84 92
95 92 60 87	90 92 51 84 96
102 88 56 79 98	83 95 57 100
97 64 48 90 99	— — 85 78
90 80 87 —	— —
62 —	

* It may be mentioned that the weighing was done with assay balance and weights by Ladd and Oertling, London.

No. 2. A white-chaffed red wheat, unbearded, open rachis. Ear $5\frac{1}{2}$ inches long. Grains very dry.

Side *a*.	Side *b*.
71	0
93 61 82	88 84
98 74 103	90 79 100
101 95 70 95	96 84 99
114 74 96 107	109 97 125
107 105 93 96	111 100 76 93
94 103 64 96 114	101 107 84 108
109 115 78 126	86 110 72 92 118
109 81 105 104	94 101 47 81 98
78 44	66 84 45 100

No. 3. Red-chaffed unbearded wheat. Ear $3\frac{3}{4}$ inches.

Side *a*.	Side *b*.
73	77
80 83	74 79
93 85	90 87
102 79 90	101 99
93 89 94	95 90 90
91 93 107	102 94
85 75 108	74 76 101
73 59 85	

No. 4. Red awny spring wheat. Ear 4 inches long.

45 53
66 69
73 43 59
71 50 77
69 71 15 83
71 72 32 77
60 71 33 74
45 47 65

No. 5. White-chaffed winter wheat. Ear 3 inches.

40
65 61
75 72
80 77
77 66 85
78 67 85
82 68 70
64 57 66

No. 6. Red-chaffed white wheat. Ear 3 inches long.

74
82 64 80
90 73 88
83 78 86
90 63 90 94
92 88 63 103
87 88 64 96
85 65 86

No. 7. Clog, English. Ear 4 inches.

58
82 78
93 71 96
105 85 95
104 84 89
94 84 65 97
72 88 67 84
97 94 75 106
100 92 67 112
94 93 43 66 90
74 80 46 68 97
72 63 54

No. 8. Clog or rivet wheat, Scots. Ear 4 inches long.

83

95 93

104 74 105

113 81 112

110 95 117

120 104 122

114 109 126

116 107 124

119 107 122

108 115 80 116

124 85 116 112

111 120 92 119

118 82 113 110

— 102 —

No. 9. Clog or rivet wheat, Scots. Ear $3\frac{1}{2}$ inches long.

59

78 78

80 53 81

86 58 86

90 68 87

90 68 88

96 72 87

97 76 93

94 78 94

92 80 90

90 78 97

95 80 53 90

82 67 80

Nos. 8 and 9 grew beside each other under equal conditions, and clearly point out the fact that the longest and largest ears of a given variety of wheat have the largest grains.

No. 10. Rivet, South of England. Ear $3\frac{1}{2}$ inches long.

61
93 42 86
91 63 98
101 68 96
106 84 107
91 83 47 110
107 92 65 104
103 90 72 113
102 75 92 92
52

No. 11. Spelt (*Trit. spelta*), unbearded, Scots. Ear $4\frac{1}{2}$ inches.

33
55 51
60 60
65 34 64
68 66
61 32 61
50 51

No. 12. "Californian," red unbearded wheat. Ear $3\frac{1}{2}$ inches.

58
62 64
63 30
84 64 75
86 44 83
91 55 85
102 60 87 87
83 98 60 84
100 77
53 86

No. 13. "Chilian," bearded, hard, solid straw. Ear 3 inches long.

76
— 110
100 62 91
106 85 113
78 65 30
112 95 103
126 — 124
112 94 119
126 100 —
100 —

No. 14. Winter, unbearded, close ear, Scots. Ear $3\frac{1}{2}$ inches.

60
66 70
68 52 67
78 67 78
74 71 46 81
76 73 53 78
73 74 53 81
68 64 77
54 37 65

No. 15. Winter, unbearded, open ear, Scots. Ear $4\frac{1}{2}$ inches long.

52
38 65
65 66
73 70
69 60 64
73 65 73
66 56 74
58 60 65
58 56 64
45 53

No. 16. Rivet of 98 corns, Scots. Ear 4 inches long.

70
106 78 108
118 80 115
116 96 116
115 109 76 122
118 104 80 106
118 114 93 104
120 90 117 118
93 92 118 127
113 116 23 96 125
104 123 49 104 125
121 123 77 105 118
97 110 92 72

No. 17. Blé Nonette de Lausanne, a bearded wheat. Ear 4 inches. French. Vilmorin and Co.

92
107 99 112
112 112 120
123 117 108
83 93 118 107
105 129 104 107
115 104 132 107
97 128 108 113
107 103 131 101
111 135 116 109
118 107 111 105
117 113 118 100
97 80

No. 18. Blé Petanielle noire de Niece. A bearded wheat, black chaff. Ear 5 inches long. French. From Vilmorin, Paris.

100
98 80 102
— 58 85 103
104 109 70 116
105 112 83 118
103 85 — 105
112 94 111 110
110 97 113 100
103 86 96 105
107 90 100 94
92 103 77 104

No. 19. Blé de Mars, rouge sans barbes. A red-grained wheat. Ear 5 inches long. French. From Vilmorin.

55 45
62 53
60 55 71
70 58 72
75 42 59 67
83 43 — 65
53 70 — 78
72 66 33 76
61 58 60
61 56

No. 20. Blé Poulard blanc lisse du Gatinais. A bearded wheat. Ear 4 inches long. French.

69
80 82
85 73 75
77 58 92
73 77 77 88
79 59 56 90
85 73 77
77 64 95
81 66 91
75 65 89
54 50 60

No. 21. Blé du Caucase ameliore. A white bearded wheat, like Spring wheat, white grain. Ear 4 inches. French. Vilmorin and Co., Paris.

80
74 72
88 72
96 76 89
105 71 90
98 84 98
87 96 58 104
107 92 97
112 89 92
34 88 100
74 75 79

No. 22. Blé Petanielle blanche. A white-chaffed, white-grained, bearded wheat. Ear $3\frac{1}{2}$ inches long. French. Vilmorin and Co., Paris.

—

89 68 100
91 76 131
137 107 106
98 108 120
131 55 122 119
78 74 96 130
101 82 114 126
129 118 86 75
112 116 98
88 73

No. 23. Blé Hickling. A compact, white-chaffed, unbearded, red-grained, wheat. Ear $3\frac{1}{2}$ inches long. French. Vilmorin.

69
70 67
76 89
83 47 82
95 71 93
97 74 93
97 80 95
108 90 103
105 93 102
98 93 103
100 64 90 95
80 85 46 82
85 59 79

No. 24. Blé a duvet. A white-chaffed, white-grained, slightly velvety, unbearded wheat. Ear 3 inches. French. Vilmorin.

52
70 66
72 78
77 62 65
86 73 82
90 79 80
88 84 60 92
43 70 87 04
85 82 65 94
81 74 61 90
— — —

* Shrivelled and ungrown.

No. 25. Blé de Zelande. An open, unbearded, white-grained wheat. Ear 6 inches long, French-grown. From Vilmorin and Co., Paris.

—

100 112
105 117
126 132
124 134
131 133
134 94 115
130 90 136
136 145
124 130
127 120

The foregoing figures are illustrative of those of the records which say that the 32 wheat grains were taken from the middle of the ear. But before discussing these I shall give a few additional weighings bearing perhaps more directly on the records which say that the 32 grains were medium grains, and good and round grains. Of such grains the total weight of 32 is given from the various samples subjoined.

No. 1. Talavera wheat. South of England.
32 corns = 32.58 tr. gr.

No. 2. Chidham white. South of England.
32 corns = 24.18 tr. gr.

No. 3. Sherriff's bearded white. South of England.
32 corns = 27.43 tr. gr.

No. 4. Kessingland red. South of England.
(contains corns = 1 gr.) 32 corns = 29.30 tr. gr.

No. 5. Nursery red. South of England.
32 corns = 24.42 tr. gr.

No. 6. Trump white. South of England.
32 corns = 25.77 tr. gr.

No. 7. Rough chaff white. South of England.
32 corns = 25.96 tr. gr.

No. 8. Red Rivet. South of England.
32 corns = 32.03 tr. gr.

100 corns = 101.13 tr. gr.

No. 9. Browick's red. South of England.
(contains corns = 1 gr.) 32 corns = 27.53 tr. gr.
32 corns = 28.45 tr. gr.

No. 10. Lammas red. Basingstoke.
32 corns = 28.55 tr. gr.

No. 11. Hunter's white. Hallett's pedigree. Basingstoke. 32 corns = 24.12 tr. gr.

No. 12. Spring red wheat. Scots.
32 corns = 25.96 tr. gr.

No. 13. White Winter wheat.
32 corns = 26.84 tr. gr.

No. 14. White Winter wheat.
32 corns = 32.35 tr. gr.

No. 15. White Winter wheat.
32 corns = 23.87 tr. gr.

No. 16. Red awny turgid wheat.
32 corns = 34.82 tr. gr.

No. 17. White wheat. Edinburgh.
32 corns = 25.20 tr. gr.

No. 18. Red wheat. Edinburgh.
32 corns = 23.79 tr. gr.

No. 19. White wheat. Morayshire.
32 corns = 21.41 tr. gr.

No. 20. White wheat.
32 corns = 24.45 tr. gr.

No. 21. White wheat. Haddington.
32 corns = 20.83 tr. gr.

No. 22. White wheat. Haddington.
32 corns = 24.22 tr. gr.

No. 23. White wheat. Haddington.

32 corns = 25.15 tr. gr.

No. 24. White wheat. Haddington.

32 corns = 20.26 tr. gr.

No. 25. A turgid wheat. Author.

Average grains 32 corns = 42.90 tr. gr.

Largest grains 32 corns = 44.35 tr. gr.

Average 1 corn = 1.36 tr. gr.

No. 26. Clog wheat. English.

32 corns = 20.50 tr. gr.

No. 27. White wheat. Mid-Lothian. "Good and round." (Contains corns = 1 grain.)

32 corns = 27.78 tr. gr.

No. 28. Red wheat. Mid-Lothian. "Good and round." (Sample contains corns = 1 gr.)

32 corns = 29.99 tr. gr.

No. 29. White wheat. Haddington. "Good and round." (Contains corns = 1 gr.) 32 corns = 30.08 tr. gr.

No. 30. White wheat. Haddington. "Good and round." 32 corns = 25.50 tr. gr.

No. 31. White wheat. Morayshire. "Good and round." 32 corns = 24.46 tr. gr.

No. 32. Polish wheat. (*Tr. Pol.*) America. "Medium." 32 corns = 32.00 tr. gr.

No. 33. Egyptian white. (*Tr. comp.*) Europe.

32 corns = 33.20 tr. gr.

No. 34. White wheat. Konigsberg.

32 corns = 20.00 tr. gr.

No. 35. Wheat. Hungarian.

32 corns = 21.30 tr. gr.

No. 36. Wheat. Port Saide.

32 corns = 26.90 tr. gr.

No. 37. Wheat. Saxonka. 32 corns = 16.08 tr. gr.

No. 38. Wheat. Hungarian.

32 corns = 19.78 tr. gr.

No. 39. Wheat. Saxonka. 32 corns = 14.24 tr. gr.

No. 40. Wheat. Konigsberg.

32 corns = 14.88 tr. gr.

No. 41. Wheat. Odessa. 32 corns = 16.96 tr. gr.

No. 42. Red wheat. Montreal.

32 corns = 17.57 tr. gr.

No. 43. Golden wheat. Minnesota.

32 corns = 18.88 tr. gr.

No. 44. A yellow Russian wheat. Minnesota.

32 corns = 20.45 tr. gr.

No. 45. Odessa red Spring wheat. Minnesota.

32 corns = 14.40 tr. gr.

No. 46. Tappahannock Winter wheat. Minnesota.

32 corns = 17.98 tr. gr.

No. 47. Premium white spring wheat. Montana.

32 corns = 21.92 tr. gr.

No. 48. White Chili club winter wheat. Oregon.

32 corns = 20.54 tr. gr.

No. 49. White Australian club spring wheat. Oregon. 32 corns = 20.80 tr. gr.

No. 50. Golden Amber winter wheat. Oregon.

32 corns = 28.42 tr. gr.

No. 51. White Sonora spring wheat. Oregon.
32 corns = 19.30 tr. gr.

From a cursory inspection of an ear of wheat, it might be inferred that all the grains are equal; this, however, as will be seen from the foregoing experiments, is not the case. In different varieties of wheat the average weight of the grains is different; and, in any given variety, the grains attain to different weights in different countries. The lightest European (Saxonka) wheat grains above, average .445 of a troy grain; while the heaviest turgid wheat grains grown by the author average 1.36 grains. The French-grown Blé de Zelande (No. 25) shows corns up to 1.45 grains; the percentage of moisture in all being not more than about 10.

In a given ear there may not be two grains of the same weight. A more or less clear perception of this fact was implied in the condition that the 32 grains forming the standard or proposed standard pennyweight, were to be from the "middle of the ear;" indeed, the terms of the Article imply that grains of wheat had to be selected of such

weight as should equal an already existing scale unit, or measure of ponderosity.

What, then, is the law with regard to variety of weight, on which an ear of wheat is constructed?

An ear of ordinary wheat consists of from three or four up to ten, twelve, or fifteen spikelets on each of two sides of an axis called the rachis. In each spikelet there are from two to five or six fertile florets or grain-cups. These grain-cups are placed alternately on two sides of a short axis, and are formed of two pales, or concave scales. The lowest grain-cup of the spikelet is the largest, though practically the two lowest, one on either side, are of the same size. The third is a little less, the fourth, still less; that is, the pales are shorter, narrower, and enclose a smaller ovoid space. The grain-cups of the lowest and highest spikelets of the ear are in general markedly less than the corresponding cups of the intermediate spikelets. The third, fourth, fifth, and sixth spikelets from the bottom of the ear, contain in general larger cups than the lower and higher spikelets, although the upward diminution is gradual and irregular.

In general the larger cups contain the larger grains. But frequently, by various accidents, the growth of a grain is partially or completely arrested, preventing it from reaching the normal size. Numbering the spikelet from the lowest floret, the first grain is generally the heaviest, the second is next heaviest, the third is lighter than the first and second, the fourth is lighter than the third, the fifth is lighter than the fourth, and the sixth lighter than the fifth. Where the spikelet contains five grains, the first is generally about double the weight of the fifth. None of the French ears in my possession shows a spikelet of more than four grains. Frequently the third grain, where the spikelet contains four or five, is heavier than the first or second. But the rule is, that the first and second are each heavier than the third. Thus in *Side a* of No. 1, the average of the two outer corns in the five and four-corned spikelets, is 92 hundredth parts of a grain, while the average of the third corns in the same spikelets is 87 of the same parts. In *Side a* of No. 2, the outer corns of four and five-seeded spikelets average 1.06 grains, the

corresponding third corns averaging 1.03. In No. 10, the outer corns of four-seeded spikelets average 1.03 grains, while the third corns average .89 of a troy grain. In No. 16, the average of the third corns is higher than the average of the first and second, the third being 1.15 and the first and second 1.12 grains.

Where the spikelet contains only three fertile florets, the difference between the first and second grains and the third is greater than where there are more fertile florets. Thus, in No. 5, the first and second seeds of the three-seeded spikelets average .76 of a grain, the third averaging .64. In No. 9, the first and second average .89 of a grain; the third average .70.

Numbering the foregoing ears from the bottom, 1 second spikelet shows the heaviest outer pair of corns in that ear; 8 third spikelets show the heaviest outer pair; 7 fourth spikelets show the heaviest outer pair; 3 fifth spikelets show the heaviest outer pair; 6 sixth spikelets show the heaviest outer pair; 1 seventh, 1 ninth, and 1 eleventh, show the heaviest outer pair of grains in their respective

ears. So that, in general, the heaviest grains in an ear of wheat occur in the third and fourth spikelets from the bottom.

Probably, where the florets are large, the canals conveying materials to the grain and the embryo, are capable of conveying the most albumen; but there are causes interrupting this law. It is not the absolutely largest grain-cups, irrespective of variety of wheat, which contain the largest grains, but the largest upon an assigned ear. For in some varieties the cups are full and the kernels partially exposed, while in others the cups largely overlap the kernels. Again, all the florets on a spike of wheat are not fertilised at the same time; a week may elapse between the fertilisation of one floret and another. It is therefore probable that a part of the difference frequently found in corresponding or nearly corresponding grains, may arise from the one having had a longer or more favourable period of ripening than the other. Probably there are other obscurer causes associated with the local conductivity of tissues in the rachis; and perhaps differences may arise from varying degrees of

fecundation (See *Cross and Self-Fertilisation.* Charles Darwin, pp. 24, 25.)

Taking the two outer corns in the 3d, 4th, 5th, and 6th spikelets of all the above English and Scots ears, the average weight is .947 of a troy grain. The same average of the nine representative French ears is 1.005 grains.

It would serve no useful purpose to give averages of whole ears; for corns of a grain weight could never have been employed indiscriminately along with corns of three quarters of a grain. If wheat corns were ever used as scale weights, they must have been selected of equal ponderosity, or must have been adjusted to equality by a little paring.

Before drawing any conclusions, let us look at the 51 samples of "medium" or of "good and round" wheat corns, above detailed. They show corns varying in average weight from 1.36 troy grains, to .445 of a grain. Seven of these samples contain good and round corns averaging 1 troy grain weight or more; and from twelve of them corns of 1 grain weight can be selected. It

is therefore obvious that a ponderal grain of any value from 1.36 troy to .445 has its type amongst these wheat corns. Most of the continental wheat corns are much lighter than the British and French. The American grown wheats are set down as showing the influence partly of geographical situation on the development of the grains, not as directly illustrating the present problem. But it can hardly be doubted that the smallness of some American and European grains, as compared with English, is due in part to defective cultivation. Indeed, some of the lighter wheats show lighter average grains than are shown by the third floret in its natural wild state, of several species of *Ægilops*.

The French wheat ears Nos. 17-25, were procured under the impression that possibly the historical fragments under consideration may be of Norman or French origin : but I do not see that these French ears, selected from fifty varieties sent me, prove anything more than is proved by the British wheats, regarding the statical facts of the present question. Whatever was the statical value of the "denarius" of the King's measure, its

equivalent may be equally found in 32 grains of French and British wheats.

Let us now consider the bearing of these figures upon the records. None of the records as existing has the stipulation that the grains shall be "dry;" this is now found only in the English version given in *The Statutes of the Realm.* The amount of moisture in wheat grains kept in barns or in stacks, evaporable at boiling point of water, is about 14 per cent of the gross weight; in the grains of the samples and ears here given, the moisture is about 10 per cent, so that they may be regarded as having the dryness proper to such grains, if kept for scale weights in a dwelling house. But the hygrostatic condition of wheat grains varies with the degree of moisture in the air surrounding them. I sent 24 wheat grains weighing 24 troy grains to a correspondent in Edinburgh, who found them on receipt to weigh 24.25 grains; next day they weighed 23.13 grains; at a subsequent time he found them short a grain and a half. But in the same house the oscillation about zero is not so great from variation of moisture, after the grains have

become thoroughly hard and dry, but that they might be used in unscreened scales for ordinary articles of commerce, without risk of serious error. This oscillation ranges as under :—

31.52 31.66 31.94 31.98 32 32.05 32.30 32.43 32.85*

It may be concluded, however, that weights varying thus were never used for quantifying the precious metals : the value of gold always generated a motive stronger than acquiescence in uncertainty.

But a still more important condition of the record in some of the readings is, that the grains shall be from "the middle" of the ear. What is the middle of the ear ? Is it half-way from one *side* of the spikelets to the other, or is it half-way from the top of the spike to the bottom ? If the middle means the central row of grains, then it is implied that the ear spoken of has spikelets of at least three florets or grains. But the spikelets must have either three grains or five grains, otherwise there is not a set of middle grains in the present sense.

In the above ears, the average weight of

* 32.85 out of doors all night.

all the centre corns of 5-flowered spikelets is .52 of a troy grain; the extremes being .23 of a grain and .77. The average weight of all the centre corns of 3-flowered spikelets is .768 of a grain; the lightest weighing .42 of a grain, and the heaviest 1.16 grains.

But it is much more probable that "the middle" means halfway between the top and the bottom of the ear, and that it is not rigidly confined to a single midway spikelet, but includes up and down about the middle. Upon this assumption, with ears of 2-seeded spikelets, no difficulty presents itself, the two grains being nearly equal; but with ears of 3, 4, or 5-seeded spikelets, a serious difficulty is encountered. These spikelets as may be observed in ears No. 1, No. 2, and others, contain grains varying between .48 and .99; .57 and 1.00; .75 and 1.08; .64 and 1.14; .92 and 1.27; .70 and 1.16, with an infinity of other similar relationships. It is therefore impossible to suppose that grains could have been collected indiscriminately from the middle of the ear to form equal weights. Some wheats, however, present the conditions of an exception to this general rule. In such a rivet as No. 8

or in Nonette de Lausanne, No. 17, the inner florets contain grains about as good as the outer.

But the cost of collecting and selecting sets of 32 corns equal to each other in weight, must always have been a practical bar to such a method of constituting a dwt.; whereas the making of a dwt. from 32 grains (little bits) of brass or silver, was an easy and certain process, and undoubtedly cheaper than the selecting of equal grains of wheat. One piece of 1 grain weight was all that was required, with other pieces of 2, 4, 8, 16 grains, or whatever series was preferred. I should certainly despair of ever selecting a set of 32 wheat grains equal to each other in weight; and my own set of 32 wheat grains are equal to 32 troy grains only in the aggregate, and that only by adjustment with the knife. The difficulty of making two equal units from wheat grains suggests the question, Was it ever done?

Similar data to those I have given might be multiplied indefinitely; indeed the foregoing ears and samples are but selections from many more; but the facts adduced seem

to embrace the general botany of the subject, and may be taken as a basis for other views than the view here proposed.

What then was the statical value of the "triginta duo grana frumenti?" Did they weigh 32 troy grains, or did they weigh 24 troy grains, or did they weigh $22\frac{1}{2}$ troy grains? No other values in connection with English metrology have been assigned to them. But it should be kept in mind that the arithmetical subdivision of a bit of lead or silver into any number of equal parts, is a different thing from the comparison by the balance of a bit of lead or silver used in ancient times, with a bit used in the present day. The same bit may be divided into 32 parts, or into 24 parts. If a given bit was at one time in England divided into 32 parts, and at a subsequent time into 24 parts, the value of the grain was altered; no reason for which alteration has harmonised it with metrological history.

We see from the present evidence that 32 wheat corns may easily be found, weighing either 32 troy grains, or 24, or $22\frac{1}{2}$, the $22\frac{1}{2}$ being equal, according to various authors, to

24 grains, Tower standard. If the 32 wheat corns weighed 32 troy grains of the existing standard, 1 wheat corn was equal to 1 troy grain; if the 32 weighed 24 troy grains, 1 wheat corn was equal to .75 of a troy grain; if the 32 wheat corns weighed $22\frac{1}{2}$ troy grains, 1 wheat corn was equal to .703125 of a troy grain. And we see before us in the evidence wheat corns of 1 grain, of .75 of a grain, and of .70 of a grain. From 16 of the ears given and similar ears, corns of 1 troy grain may be collected; and also, as already stated, from 12 of the samples given. A good many of the ears and samples contain corns which by a little paring may be adjusted to .75, or to .70 of a grain, for it is but rarely that a corn turns up of an exact troy grain weight, or of exactly .75, or of exactly .70; and if such corns did frequently turn up in one hygroscopic state of the air, they would alter their weight in another state.

The result, therefore, of the botanical part of this inquiry is, that it cannot be determined with certainty from wheat corns, what was the metrical value of the 32 grains forming the basis of the King's measure. But

taking "good and round" corns, and corns from the exterior rows of the middle spikelets of wheats known to have been anciently cultivated in England, the balance of the evidence is in favour of the position that the "xxxij grana frumenti" were equal to 32 troy grains.

But even supposing it were not contradicted by historical facts, it is impossible to believe that a metrical system could have been initiated in England after the Conquest by wheat corns. Any man may easily make 32 metal grains equal to each other, but no man will ever find 32 wheat grains equal to each other. Metallic weights have been in use from Egyptian antiquity; they were always easier made than the coins or goods, for weighing which they were used; and all the meaning we are entitled to look for in the wheat corns of the King's Measure is a selection of corns to form a popular equivalent of an existing or proposed metallic standard; or to give a popular conception of what that standard was, and wherein it differed from some other.

It is said that the eastern jewellers weigh

gems with the carob bean, understood to be a diamond carat of 3.2, or 3.166 troy grains. Upon weighing thirteen carob beans, they were as follows :—3.38, 3.57, 3.54, 3.50, 3.05, 3.36, 3.53, 2.95, 4.07, 3.18, 3.02, 2.89, and 2.46 ; so that it is evident these beans cannot be indiscriminately used as carat weights. The average weight of seventy-two gave 3.163 troy grains, showing that from a large number of carob beans individuals may be selected of exactly a carat weight ; and pointing out, that wherever seeds are used as weights, they are used because they are found equal to a previously existing metallic standard. No doubt the 32 wheat-corns were equal, or were assumed to be equal, to a standard of metal weights already in existence. The common people did not know about grains of brass, and therefore they were told that the grains were of wheat. But the qualification that they were to be " medium," or " middle-ear," or " good and round " grains, pointed out that corns of a certain size had to be selected in order that they might harmonise with a fixed dwt. There was no reason why the number should be 32, except to indicate that

the dwt. of the king's measure was to be a third heavier than the dwt. of the king's money, which was known to be 24 of the same wheat and metal grains; because it is just as easy to find 29 wheat corns as 32 equal to an assigned weight; and if the 32 had not a permanent weight fixed in a metal standard, the number 32 of fluctuating corns had no arithmetical value as a submultiple whatever.

It is not proposed here fully to apply historical considerations to these botanical facts; this will be done in a separate treatise; but a few hints may be given of the direction which will probably be pursued. The reader may also examine the plate of *Troy weights*, in which is exhibited what I believe to be the true genesis of the two systems which came to be recommended in presence of competing systems, by the name of "droit pois," "right weight," "troi weight," pointing thereby simply to the standards introduced into England by the Normans.

As already stated, all the records agree in saying that it was the king's "measure" which was to be based on 32 grains. It was

not the king's *money*. The law is said to have had the "consent" of the whole realm; or to have been decreed by the whole kingdom. Fleta says, the king's measure was made "by the determination of the more discreet men of the whole kingdom." Was not Fleta the first to put this metrological record into its present shape? Now, weights and measures have usually had parliamentary sanction or such an equivalent as is here implied. But is there any instance in which the consent of the whole kingdom has invaded the royal prerogatives in the mint? No new standard of the money penny was made in the reign of Henry III., nor perhaps in the reign of Edward I. The money penny, in all its varieties, was not left to be initiated from wheat corns even under the Saxon kings, much less under the Norman. The money esterlin penny was well known in England and Scotland long before the earliest date assigned to the article of the 32-grain dwt.; while the Saxons had metrical units, local and imperial, in all parts of the country. When the Conqueror was particular about a sum on the *Terra Regis*, he sometimes specified that it

should be "ad pensum," and sometimes that it should be of pennies which were "xx. in ora." *

Thus the ora or ounce (of some value), and a dwt., its 20th part, were defined and

* It is observed by Clarke (*Connexion of the Roman, Saxon, and English Coins*, p. 309) that "Bishop Hooper thought Mr. Somner's opinion (that there were two sorts of ora, the one of sixteen, the other of twenty pence) would be much more intelligible, if this difference was supposed to subsist, not in the ounces but in the coins." But Hooper's conjecture has been lost sight of, although undoubtedly it was right. If at the date of the Domesday Survey there had been two money oras or ounces, the one containing 16 and the other 20 pence of equal coins, as Dufresne and others have held, such an entry as that the county of Oxford had to pay "pro canib. xxiii lib. denar de xx in ora" (for dogs 23 pounds of pence of 20 in the ounce), would have been the same contribution if stated, *pro canib. xxiii lib. denar de xvi in ora;* because in both cases the pound would have contained 240 of the same coins. But the implication of "xx in ora," was not that there were two money oras, but that there were lighter coins legally in circulation, passing "ad numerum" or otherwise, and that in the payment in question these would not be accepted. The last of the sedecimal pennies, or pennies of xvi in ora, were coined by the Confessor, and are represented by such coins as one in the author's possession of 26.86 grains and some of Ruding's of about 27 grains, the true weight probably being 27.37 grains, or $\frac{1}{16}$th of the Roman ounce.

perfectly known at the Conquest. No doubt there were other money pennies of less weight, but they were determined by metallic standards, not by wheat corns.

I have found reason to conclude that the money "sterling" was systematically introduced into the English coinage in 1175. What was the "sterling?" The various derivations cannot be here considered; but the conclusion to which I have been shut up is, that when Henry II. brought the Norman standard mint weights to England, he necessarily brought the *esterlin* scale-weight. The sterling was neither from a coinage originated at Stirling, nor from a people called Easterlings; the "esterlin" or "sterling" was simply the name of the 20th part of the ounce, just as the "felin" or "ferling" was the name of the 80th part; the "maille" or "obole," the name of the 40th part; the "denier," or "penny," the name of the 24th part; the "grosse," or "groat," the name of the 8th part; coins of corresponding weight being called by the same names.

The 20th part of the Norman ounce was called an "esterlin" (from whatever more

remotely derived), while the 24th part was called a "denier;" but the denier was dropped out of English metrology, the esterlin becoming "the penny of England."

But there was certainly no specific characteristic in the English and Scots sterlings to differentiate them from the coins of David I. and the coins of the Anglo-Saxon kings. Therefore Easterlings (if there were any such special coiners) did not introduce a new species of English coins. The sterling differed in nothing from older or contemporary coins except in weight; it weighed an *esterlin*—minus the remedy—when honestly turned out, which was not always the case, even in the king's mint.

That a certain coinage had been originated by a certain people, or at a certain place, could have been no recommendation to coins struck in England; but the silver esterlin, as a known equivalent of the esterlin scale-weight, carried its certificate in its hand; turned the beam against all the deniers or pennies then in currency; made the "pound of the Normans," "ad numerum" equal to the pound "ad pensum," and became the

popular favourite. Other coins might be "pennies;" it was a sterling.

Thus sterling money was simply money weighing esterlins. A "penny" of any weight might have been cut by the Easterlings, or the moneyers of Stirling; but the attribute of *esterlinity* was the being 1-20th of the Norman ounce, or that value of it (probably a little too heavy) which had become standard in England. And the reason why those of the Domesday pennies which were "xx in ora" were not called esterlins, was simply because the Norman standard weights, with their French names, had not been introduced at the time of the Survey; and because the 20th of the Roman ora was not called by the name of esterlin.* Perhaps an asterisk or estoile was stamped on the *esterlin*

* Ruding, citing Le Blanc, gives the first mention of "sterling" in 1158. But Odericus Vitalis, who died about 1143, describes the income of the Conqueror as "sterilensis monetæ" (*Excerpta ex Orderico Vitali*, p. 258, MASERES). Both these may be found interpolations. One thing is certain, the Conqueror's own coinages were not of the esterlin standard weight. Probably "sterling" does not occur in the rolls earlier than 1184.

scale-weight to distinguish it from the *denier*.

It must here be taken for proved, that the money esterlin scale-weight, at its introduction into Britain, was divided into 24 parts or grains. According to Paucton, the "livre Carlovingienne" was divided into 5760 grains, and consequently the vigesimal denier into 24 grains, from its institution (*Metrologie*, etc., ch. 13, 1780). And we have seen that Stow's authority as to the substitution of 24 for 32 is unsupported. But the grains were metal grains and not wheat grains; and this esterlin, or 20th of an ounce, was an element of the mint pile, or standard used in quantifying the precious metals and some other valuable articles. It was the older Roman method of subdivision which had given rise to 24 deniers, pennies, or scruples in the ounce, and 288 in the duodecimal pound. And when Charlemagne instituted the subdivision of the pound into 20 sous and 240 deniers, the new denier, by whatever name at first known, had the relationship to the pile of the esterlin. The subdivision of the pound weight into 20 shillings of 12 pence each, made the

240th part an organic element of the system, requiring a name to distinguish it from the 288th part, or scruple. The name given was the esterlin.

But ordinary commercial weight has nearly always been formed of heavier standards than money weight. The avoirdupois pound, connecting our national history with the Romans, and the troy pound, connecting our history with the Normans, are types of the greater and lesser standards which have existed in nearly all trading countries. And the intention of the "statute" or article under review, whether introduced by general consent, or in some less conspicuous way, was to establish in England the Norman commercial standard, which was a third heavier than the money standard, but based upon the same root. The money dwt. was 24 grains, and therefore the commercial dwt. was defined to be 32 grains, each grain being of the same value as a grain of the money standard. And probably because the common traders, to whom it was wished to recommend the new standard in lieu of the Roman avoirdupois, were unacquainted with metal grains, the definition was made clear by

laying down that the grains were equal to medium grains of wheat, or grains of wheat from the middle of the ear: and we have seen that grains of wheat may readily be collected equal to the only metal grains which have ever been known in English metrology. The proposal therefore stood thus :—

32 grains of wheat	= 1 stg. dwt.	=	32 troy gr.
20 dwts. „	= 1 ounce	=	640 „
12 ounces „	= 1 pound	=	7680 „

The sterling pennyweight here spoken of was not, as has erroneously been supposed, the Mint or Exchequer sterling, but the market sterling, "genus ponderis;" it was not the root of the King's money, but the root of the King's measure—which anciently included weight; and the pound thus formed was not the money pound, but what was called the "pound of London," and was equal to 2 marks of money weight, or 16 money ounces, and also to 12 commercial or tron ounces. The money sterling weight was 24 grains, the commercial sterling of the tron, 32 grains. The relationship of the two standards may be shown thus :—

	Grain.	Ferlin.	Maille.	Denier.	Sterling.	Grosse.	Ounce.	Marc.	12 oz. lib.	15 oz. lib
Money Standard.	1	6	12	20	24	60	480	3840	5760	
Commercial Standard.	1	8	16	$26\frac{2}{3}$	32	80	640	5120	7680	9600

The Roman method of generating or sub-dividing the money pound was retained in some parts of France after the establishment of the standards of Charlemagne, and was introduced, along with the French money standard weight, into Scotland under Queen Mary.* The Normans seem to have adopted the subdivision of Charlemagne and to have brought it into England, where it still remains. It continued in Scotland along with the English troy standard till the reign of Mary. The two modes of subdivision are shown in the subjoined table; and no doubt the one was sometimes used and sometimes the other in the same mints, for reasons which need not at present be entered upon.

* This, and various other insufficiently supported positions may be thought to be fully turned by such recent works as those of Mr. Cochran-Patrick (*Records of the Coinage of Scotland*); Mr. E. W. Robertson (*Historical Essays*); and Mr. H. W. Chisholm (*On the Science of Weighing and Measuring*). I can only, with diffidence, at present ask the reader to suspend his verdict.

Table of Roman and Carlovingian subdivsion of the Money Pound.

										Values in Eng tr. gr.
Lentes;* French grains										Roman .76 / French .82
	Grain									1.00
12		Obolus; obole								R. 9.12 / F. 9.84
	6		Felin; ferling; farthing							6.00
24		2		Scruple; denier; penny						R. 18.25 / F. 19.68
	12		2		Maille; obole; halfpenny					12.00
36		3		1½		Dram; penny				R. 27.37 / F. 29.53
	24		4		2		Esterlin; sterling; penny			E. 24.00 / F. 23.62
576		48		24		16		Ora; ounce; once		R. 438.0 / F. 472.5
	480		80		40		20		Ora; ounce	480.00
6912		576		288		192		12	Libra; livre; pound	R. 5256 / F. 5760
	5760		960		480		240		12 Lib.; li.; pound	5760

The light figures in the Table are the Roman and French units; the dark figures are the Norman and English.

* The weight of Lentils tested by the writer varied from .89 to .75 of a troy grain; five averaged .771 of a grain; but heavier and lighter may easily be found.

Conjectures have been ventured as to the date at which the subdivision of the sterling was changed from 32 grains into 24; the subdivision was not changed at any date; the two pennyweights were of different values, and their history has been misappre-

hended. The contention of Folkes (*Tables of English Silver and Gold coins, etc.*, 1736 and 1745), which is very generally accepted, that the money sterling was 24 Tower grains, or equal to 22½ troy grains, has certainly been accepted on insufficient proof. The proof goes to show that the Tower pound was a mere numismatic unit; that there never was any such thing as a public system of Tower *weight*, that the constituents of the Tower pound were of the troy standard, that the Tower pound at its institution by one of the Edwards was a mere reduction of the troy pound for fiscal purposes, of a similar kind to the subsequent reduction of the same pound by David II.

It is at this point that some of the old standards begin to be called *troye, troi, troyis, trois, troes;* the earliest mention of troy I have found being in an Act of Robert III. (1393), reciting that Bonachius of Florence is to make "sex unceis troye" of pure silver into twenty-one shillings. The notion that a new standard had been introduced from the town of Troyes has no foundation whatever, nor are the other half-dozen derivations in

any better position. The word *troi* is not derived at all, it is simply a different way of writing "droit.'* When the Tower pound and the reduced pound of David II., and the pound of 7680 grains had been partially introduced, the ponderal standards favoured by the government were called "droit pois," as we see from the French Acts (25 Edw. III., Stat. 5, c. 9). Certain standards were "droit pois," "right weight," hence "troi weight," meaning thereby the approved standards, whether of money weight, or commercial; the qualification becoming technically attached to the old Norman units. Under these views, this branch of British metrology becomes an organic whole.

I shall subjoin only a single historical proof that the 32 wheat grains of the King's measure were equal to 32 grains of "right weight."

The stoup of Stirling is the oldest standard of length, capacity, and weight, now existing in Great Britain. The proof must

* The old monogram on weights was ℞ (DR), afterwards becoming ℟ (TR). *Coinage of Scotland.* INTRODUCTION.

be deferred that it is based upon the Roman standards — more probably corrected from time to time by the Catholic clergy, than handed down from the Roman occupation. The Stirling stoup is in fact a semi-congius, and as such should contain 3 sextarys. The Roman sextarius contained 20 ounces of water. The value of the Roman ounce, as deduced by Greaves (*A Discourse of the Roman Foot and Denarius, etc.*, 1647), is 438 troy grains. Therefore the stoup of Stirling should contain (438 × 20 × 3) 26,280 troy grains of clear water.

Many measurements have been made of this stoup. Those which have been made with the utmost refinements of science, probably no better, but rather, less closely, represent the ruder intention of its forgers, than measurements more nearly resembling the simpler methods of testing, antecedent to barometers, thermometers, and distilled water.

Dr. Adam Anderson of Perth found the Stirling jug to contain 26,286.41 grains of pure water (*Report on the Stirlingshire Weights and Measures.* 1827).

In the fourth "parliament or assise" of James I., held at Perth in 1426 (*Scots Acts* II.), it is laid down (ch. 70) that the pint "sall conteine be weicht of cleare water of Tay, fourtie-ane ounce: That is to saie, twa pounds and nine ounces trois."

Therefore, dividing 26,286 grains as above by 41, we get an ounce of 641 grains, and a pennyweight of 32.05 grains. The trois ounces here mentioned, elsewhere called "leil trois," are simply the "droit" or right weight of the commercial or tron ounce of the Norman standard. The approximation is unexceptionable.

It is perfectly clear that the Scots parliament were not inventing a new pint stoup, nor a new ounce weight; they simply filled the old stoup from the water of Tay, and set it in one scale of the balance, and then in the opposite scale put the old leil and true ("droit et leal," LIBER ALBUS) ounces of the tron weight, till the nearest whole ounce poised the beam, and declared the result in the formula of a statute. But the tron weights were "droit," "troi," the right or imperial standards, as well as the mint

weights,* only they were a third of the lesser weights, heavier; the mint dwt. was 24 grains; the tron dwt. was 32 grains.

I have stated that the Stirling stoup is the semi-congius. In the assises attributed to David I. (*Scots Acts*, vol. i.) it is laid down that the gallon consists of 12 pounds of divers waters. The gallon weighed 12 pounds, but of what value were the pounds?

In the Act of James I., already referred to, it is stated that the gallon of David I. "weyed ten pound trois and four ounce of diverse waters." So that $10\frac{1}{4}$ pounds trois are equal to the 12 pounds of the older definition. We have just seen that the trois ounce of the Stirling stoup is 641 grains. Sixteen times this ounce make the *droit* tron pound, 10,256 grains. Ten and a fourth times this pound make David's gallon 105,124 grains. And dividing this sum by 12 we find that David's "pound" was 8760 grains, or a sextary pound of 20 Roman ounces, and

* It is from overlooking this consideration that Lord Swinton's "Conjectures concerning the ancient Weights and Measures in Scotland" are essentially vitiated.

one-third of the Stirling stoup; which was thus one-fourth of David's gallon.

Thus, what is now the Scots pint, but which was at an earlier period a quart or quarter of David's gallon, has stood sponsor for three systems of weight. The English pint was one Roman sextary; the Scots was three. Under David I. the stoup contained 60 ounces. Dr. Anderson's determination of the stoup, as above, was 26,286 grains which divided by 60 gives the old British value of the Roman ounce as 438.1 grains; being practically what it was found upon very different data by Elizabeth's second Jury. Under James I. of Scotland the stoup contained 41 ounces. From the same determination, these were each 641 grains of droit weight. Under James VI. the Stirling stoup contained 55 ounces of "Frensh troyes," each of which by the same datum weighed 477.93 grains. These were called "Frensh troyes," but it is impossible to doubt that the standard was the same as that of the old English mint, and the standard of James I. The nest or pile of troy weights of date 1572, the oldest standard weights in the kingdom,

still in the Museum of Perth, give an ounce of 478.3 grains, and were probably the weights used to test the stoup in 1618. Beside them stands the pile of troy weights (mistakenly called "Scotch Troyes" by the Jury of 1826) sent down from the English Exchequer at the Union, giving an ounce of 479.6 grains. Who can doubt that the two piles were from the same original, thus slightly varied by imperfect adjustment?

Evidently the experimenters of 1426 and 1618 give the jug only to the nearest whole ounce, and it is quite possible that the 41 troy ounces of the tron may have been exactly commensurate in weight with the 55 troy ounces of the mint and the shops; but as subdivided into 480 and 640 grains, there is a slight arithmetical discrepancy. Numerically the three standards which have appealed to the stoup stand thus :—

Stoup of Stirling * . .	=	26,286 grains
Roman ounces 60×438 .	=	26,280 „
Leal trois of the tron $41\frac{1}{16} \times 640$	=	26,280 „
Troy of the shops $54\frac{3}{4} \times 480$	=	26,280 „

* The author's measurement of the Stirling Jug with clear water of Tay gives 26,272, and with water of the Water of Leith, 26,288 troy grains.

So that 41 ounces and 1 drop of the King's measure are arithmetically equal to $54\frac{3}{4}$ ounces of the King's mint, upon the original basis of 24 grains and 32 grains. The "pound of London" was proposed to be generated from 12 ounces of 640 grains, making 7680 grains; but probably this pound, where accepted, has mostly been formed of 16 ounces of 480 grains. The "libra mercatoria," merchant's pound, of 15 ounces, was probably 15 ounces of 640 grains, or a pound of 9600 troy grains—one of the values of the tron pound. Or if we take the tron ounce as 641 grains, 15 ounces make a pound of 9615 grains; the Edinburgh standard being 9622 grains. "Merchant" in the middle ages signified a large trader weighing heavy goods at the tron, and no proof exists that ever a pound was in use in England of 15 mint troy ounces, or 7200 grains. We see from the Act of 1426, that the tron pound in Scotland was at that time 16 ounces of 640 grains, the 41 ounces being otherwise stated as "2 pounds 9 ounces."

Thus, with the assumption that the 32

wheat grains of the King's measure were equal to 32 troy grains, one large section of British metrological history becomes organic and clear.

THE END.

Printed by R. & R. Clark, *Edinburgh.*

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